The
WIRELESS ENGINEER

A Journal of Radio Research & Progress

Editor
HUGH S. POCOCK

Technical Editor
Prof. G. W. O. HOWE, D.Sc., M.I.E.E.

VOL. XIII. No. 156

SEPTEMBER 1936

CONTENTS

EDITORIAL 459
AUTOMATIC LINE LEVEL RECORDING APPARATUS. By F. A. Peachey, D.F.H., A.M.I.E.E. 462
CONDITIONS IN THE ANODE SCREEN SPACE OF THERMIONIC VALVES. By H. C. Calpine, B.A. 473
A PORTABLE DUPLEX RADIO-TELEPHONE. By W. B. Lewis, Ph.D., and C. J. Milner, B.A. 475
HIGH VOLTAGE CATHODE-RAY TUBE FOR HIGH-DEFINITION FILM SCANNING. By Manfred von Ardenne (Abstract) 483
NOMOGRAMS FOR SYMMETRICAL ATTENUATION CIRCUITS. By E. A. Hanney, M.Eng., Ph.D., A.M.I.E.E. 486
ABSTRACTS AND REFERENCES 488
SOME RECENT PATENTS 515

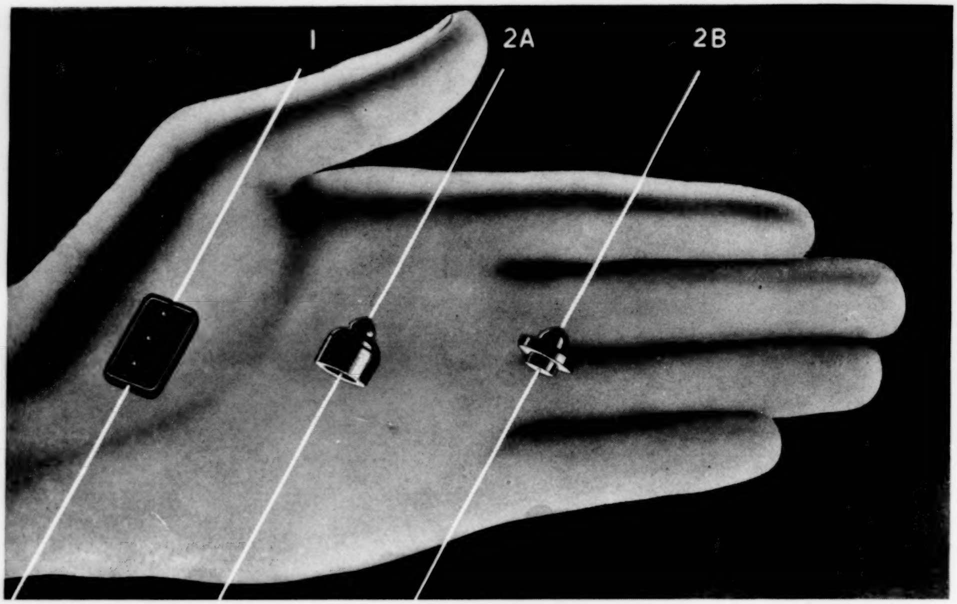
Published Monthly on the first of each Month
SUBSCRIPTIONS Home and Abroad: One Year, 32/-, 6 Months, 16/-. Single Copies, 2/8 post free

Editorial, Advertising and Publishing Offices
DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1
Telegrams: "Experiwyr Sedist London" Telephone: Waterloo 3333 (50 lines)

Branch Offices

COVENTRY	BIRMINGHAM	MANCHESTER	GLASGOW
19 Hertford Street	Guildhall Bldgs., Navigation St., 2	260 Deansgate, 3	26B Renfield Street, C.2
Telegrams: "Autocar, Coventry"	Telegrams: "Autopress, Birmingham"	Telegrams: "Iliffe, Manchester"	Telegrams: "Iliffe, Glasgow"
Telephone: 5210 Coventry	Telephone: Midland 2971 (4 lines)	Telephone: Blackfriars 4412 (4 lines)	Telephone: Central 4587

The Editor invites the submission of articles with a view to publication. Contributions which are not exclusive should be so described when submitted. MSS. should be addressed to the Editor, "The Wireless Engineer," Dorset House, Stamford Street, London, S.E.1. Especial care should be taken as to the legibility of MSS. including mathematical work.



Condensers condensed

These new and minute condensers will interest principally radio manufacturers and industrial users, to whom they are available exclusively for the time being. But we hope the trade as a whole will also recognise them as part of our contribution to more reliable and efficient sets. Briefly, these are our new " models ":—

1. *Moulded Mica Condenser.* Type 635. This is the smallest moulded mica condenser ever made in this country.
2. *Ceramic Condensers* (a) Cup type, (b) Disc type. These are not only interesting for their technical advantages, but also because they are at last entirely British Made.
3. *Metallised Mica Condenser.* This also is now entirely British Made and is available in many different forms.
4. *Wet Electrolytic Condenser.* This is one of the most interesting additions to our range.
5. *Non-Inductive Tubular Paper Condenser.* This is a new and improved design of a previous type incorporating many valuable features.

But these are only a few of our latest "models." A complete range of modern condensers and resistances is in the two new catalogues we have produced—one for the manufacturer, designer and trade service, and the other for the constructor. We shall be very pleased to send you your copy.

DUBILIER
CONDENSERS

DUBILIER CONDENSER Co. (1925) Ltd., Ducon Works, Victoria Road, North Acton, London, W.3

C. R. Casson 107

THE
WIRELESS
ENGINEER

VOL. XIII. SEPTEMBER, 1936. No. 156

Editorial

Hyper-Frequency Wave Guides

IN our June number we published an editorial article entitled "A New Type of Wave Transmission," in which we described a remarkable series of experiments recently carried out at the Bell Telephone Laboratories in New York by Dr. Southworth. In these experiments ultra-short waves were transmitted along the interior of a metal tube, the magnetic and electric fields being confined entirely within the tube. Four different types of waves were described in an elementary manner. A mathematical investigation of the problem by Carson, Mead, and Schelkunoff has been published in the Bell System Technical Journal. We have pleasure in reproducing photographs of the experimental equipment at the Holmdel Radio Laboratory of the Bell System. Fig. 1 shows two transmission tubes or wave guides; they are copper pipes, one 4in. and the other 6in. in diameter and 1,250 feet long. In Fig. 2 Dr. Southworth is holding one of the resonant chambers used for tuning purposes, whilst in Fig. 4 he is operating an iris diaphragm aperture which acts as the coupling between the transmitter chamber and the line. The valve generator can be seen in the transmitter chamber; the tubular line has been removed in this view. Fig. 3 shows the sending end of the line, and Fig. 5 the receiving end. The sending apparatus is operating on the 6in. tube line; the open end of the unused 4in. tube line can be seen on the left.

The apparatus and methods employed are entirely different from those employed in the usual type of transmission. The transmission of these electromagnetic waves along the inside of a pipe is very analogous to that of sound waves along a speaking tube and the methods of tuning and matching impedance are also very similar. As the

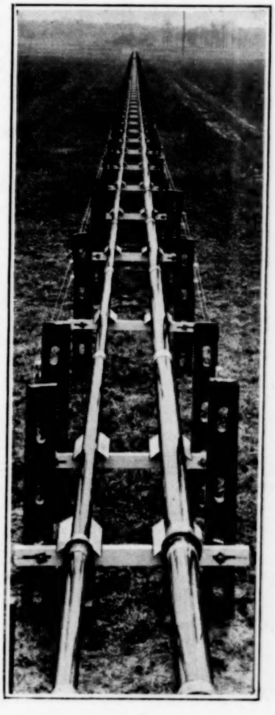


Fig. 1.—*Photograph showing how the transmission tubes were laid out as wave guides.*

wave-length of radio transmission is decreased, the sharp line of demarcation between the parts of a circuit functioning as inductance and capacitance gradually vanishes and the oscillatory circuit merges into a section of tuned transmission line. A familiar example of this is the Lecher wire with the sliding bridge piece to adjust its length. In the present example, since the waves are entirely within the tube, the sliding bridge piece becomes a metallic piston in good spring contact with the tube at every point of its periphery, and the resonant line becomes a resonant chamber such as Dr. Southworth is examining in Fig. 2. In Figs. 3 and 5 the apparatus terminates with such a tuning adjustment operated by means of a milled head acting on the piston-rod. In the transmitter (Fig. 3) the piston acts as a tuned reflector to the valve oscillator, the terminals of which can be seen just to the right of the vertical tube; then, at the operator's hand is the adjustable iris diaphragm—seen in detail in Fig. 4—which also serves to adjust the tuning of the chamber and its coupling to the line. The vertical tube to which we have just referred is the wavemeter; it is a concentric transmission line of the usual type, that is to say, it actually has a fixed central conductor which projects down into the main transmission tube sufficiently far to pick up some of the energy. A piston slides up and down, making contact with both the inner conductor and the outer tube; the position of the piston is adjusted by means of the milled nut at the top of the tube until this side tube resonates as indicated on a galvanometer connected to crystal detector actuated by a wire which projects into the vertical

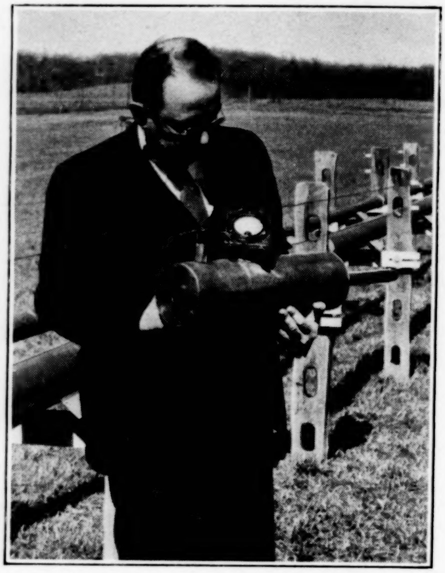


Fig. 2.—*One of the resonant chambers which provide the means of tuning being examined by Dr. Southworth.*

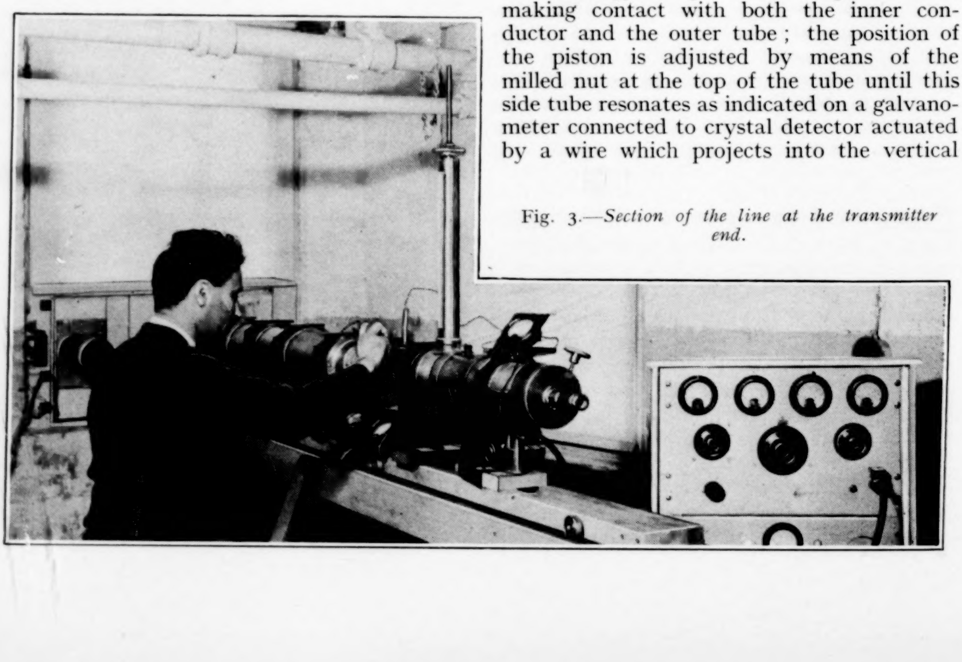


Fig. 3.—*Section of the line at the transmitter end.*

tube near its base ; this can hardly be seen in Fig. 3. An index attached to the piston projects through a slot in the tube and moves over a scale of wavelength.

The line is terminated by a tuned chamber coupled to the line by a suitable aperture and containing the detector unit or pick-up which must be suitably placed and adjusted to absorb the maximum amount of power. Dr. Southworth found the most satisfactory form of detector to be a silicon crystal mounted on the side of the tube and operated by a wire projecting into the tube, as was done in the case of the wavemeter at the transmitter. To investigate the presence of standing waves in the tube a longitudinal slot was cut, along which the detector and its probe could be moved ; Fig. 5 shows this experiment being performed. The investigator is moving the detector along its slide and noting the variation of the galvanometer deflection.

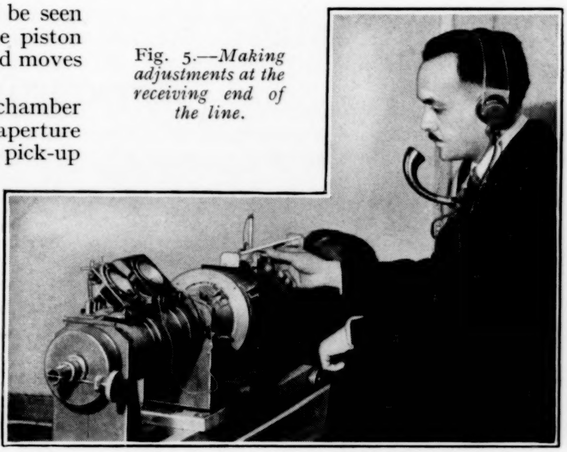


Fig. 5.—*Making adjustments at the receiving end of the line.*

Whatever may be the practical value of these new types of wave transmission, the experiments are certainly of very great interest. G. W. O. H.

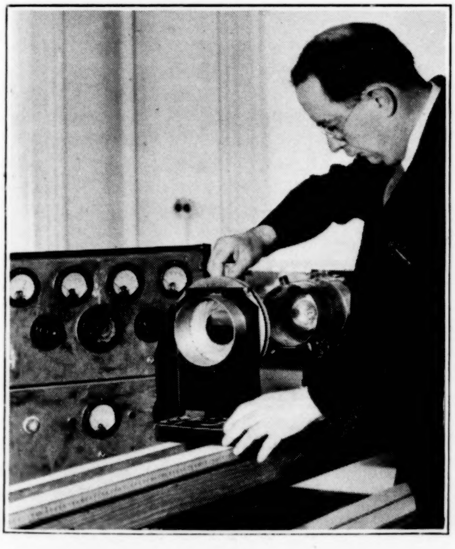


Fig. 4.—*The Iris diaphragm, which provides the coupling between the transmitter and the line, can be adjusted as shown in the photograph.*

British Radio Show
Olympia
August 26th to September 5th

THE annual Radio show, which is being held at Olympia again this year, opened on August 26th and will close on September 5th. The date of the Show makes it impossible for us to examine the exhibits and include a report in this issue, but arrangements have been made to devote a number of pages to a review of the Exhibition from the engineer's point of view in our next number.

The outstanding feature of this year's exhibits amongst broadcast receivers is the number of models where short-wave tuning ranges have been included, and from the designer's point of view considerable ingenuity has been displayed in arranging for short-wave reception with the minimum of elaboration of the receiver as a whole. There has been a notable increase in apparatus designed for the service man and for the use of designers in laboratories. This equipment, in particular, will receive attention in our report next month.

Automatic Line Level Recording Apparatus*

By F. A. Peachey, D.F.H., A.M.I.E.E.

(Lines Department, The British Broadcasting Corporation)

APPARATUS for the automatic recording of frequency response characteristics has been in general operation for some years, but it is only recently that its use has been widely extended to the measurement of lines used for broadcasting purposes.

It has a great advantage over the existing purely manual methods in that the process is continuous and rapid and almost eliminates personal errors due to bad operation.

With this in view automatic apparatus of this nature is being tried out for the testing of station to station lines used by the British Broadcasting Corporation, and this article describes the system as a whole with some details regarding the novel ideas which have been incorporated in it.

In designing the apparatus, problems had to be faced, such as the fact that every station was already equipped with manually-operated transmission measuring systems. From the point of view of space and initial cost, it was obviously desirable to adapt existing apparatus as far as possible to the new requirements, and yet leave it so that either manual or automatic measurements could be made. Initially, these factors influenced the design of this equipment, but even if existing apparatus were not available, it is felt that having regard to cost, reliability and simplicity of operation, the methods employed would still be well worthy of consideration.

The system will be dealt with in two main parts, the "sending end" and the "receiving end," although it will be appreciated that a complete terminal equipment comprises both sending and receiving apparatus.

In this particular case the apparatus has been constructed to occupy part of the space on two vertical and adjacent steel racks. The racks are constructed of channel steel uprights spaced 22in. apart and fitted with the necessary cross-bars, fixing brackets and terminal blocks, similar in many respects to those in normal use by the G.P.O.

A satisfactory distribution of apparatus is shown diagrammatically in Fig. 10, from which it will be seen that the left-hand rack contains :—

(1) The condenser and automatic drive mechanism associated with the heterodyne oscillator (panel depth 18in. approximately).

(2) The complete receiving and recording equipment mounted on one panel (panel depth 18in. approximately).

The right-hand rack contains :—

(1) The heterodyne oscillator and its associated amplifier (2 panels, each 9in. depth approximately).

(2) The transmission measuring set (panel depth 9in. approximately).

Each rack has its associated jack strip and battery supply panel, together with miscellaneous transmission apparatus used for other "local" testing purposes, and hence not shown on Fig. 10. The condenser and its associated automatic driving mechanism are supported on their panel by rubber blocks insulating the other apparatus from mechanical vibration.

"Sending End"

It will be seen from Fig. 5 that the oscillator is of a conventional heterodyne type. Two separate oscillating valves are inductively coupled to a valve rectifier stage through a simple tuned circuit, adjusted to pass the fundamental frequency of the fixed frequency oscillator and attenuate harmonics. Under these conditions it is well known that the output of the rectifier will comprise mainly the oscillator frequencies and their sum and difference frequencies.

In this particular case the frequency of one oscillator is fixed at 100 kc. approxi-

---

* MS. accepted by the Editor, January, 1936.

mately while the other is variable from 100 kc. to 80 kc. Thus " beat " frequencies of 180 to 200 kc. and 0 to 20 kc. are produced by the rectifier.

By means of a simple filter circuit (see Fig. 5) between the output of the rectifier and the first low frequency amplifier stage, the higher frequency band is eliminated and the frequencies 0 to 20 kc. are amplified by two low frequency valve stages in the normal manner.

In the variable frequency oscillator circuit there are two variable condensers, one providing means of adjusting the beat frequency to zero (i.e., adjusting the two oscillator circuits to the same frequency when the main dial is on zero), and the main condenser calibrated in terms of beat frequency.

As originally designed this oscillator was intended for manual operation only, and a small variable condenser for adjustment of the beat frequency was augmented by a number of fixed condensers which could be switched into the oscillator circuit to provide the complete low frequency range 0 to 20 kc.

In order to provide output adequate for all normal transmission measurements, the output of the oscillator is fed to a separate low frequency amplifier comprising two stages of push-pull amplification, capable of delivering at least 320 milliwatts into a 600-ohm load, with inappreciable wave-form distortion.

Means of measuring the output of the oscillator and its associated amplifier are provided by a transmission measuring set (see Fig. 5). This also is of standard type.

Tone from the oscillator amplifier is fed via an input transformer and thermo-couple to a potentiometer or level switch. Switching arrangements are provided so that the thermo-couple and its associated galvanometer may be calibrated for one particular value of current from the direct current supply, and then used as a means of adjusting the alternating current in the input circuit of the transmission measuring set. In this respect the circuit is arranged to calibrate conveniently at a current value, which at the " send out " terminals of the set produces a voltage such that 1 milliwatt will be sent into a 600-ohm resistance, i.e., " zero " level.

This applies, of course, when the level switch is set to the " zero " level position. Other levels, above or below, may be sent by appropriate adjustment of the level switch.

The calibration will, of course, hold good only for load resistances of 600 ohms, and for all other loads suitable correction must be made.

The transmission measuring set also provides means whereby the gains or losses may be measured by direct or comparison methods but for the purposes of automatic frequency response recording, these facilities are not required.

Thus the only equipment required to convert to automatic operation was an external condenser replacing the existing condenser of the oscillator and driven in such a way that it would vary the frequency in accordance with the required time law. The law established by the C.C.I.F.* is that the frequency should start at 30 p.p.s. and in 15 seconds rise to 100 p.p.s. linearly with time. Then from 100 to 10,000 p.p.s. a logarithmic law should be followed, so that at intervals of 15 seconds the frequencies are as follows:

30, 100, 200, 400, 800, 1,600, 3,200, 6,400, 12,800.

Furthermore, 6.5 seconds before 30 p.p.s. commences a tone (for the starting of apparatus at the receiving end) should be sent for a period of 1 to 2.5 seconds at a frequency of 1,300 p.p.s.

As mentioned previously, on the existing oscillators the range 30 to 10,000 p.p.s. was covered by a variable condenser augmented by fixed condensers. It followed, therefore, that the existing condensers could not be used for this purpose.

The process usually employed is to drive the variable condenser at constant speed, the plate shape of the condenser having been designed to fulfil a linear law from 30 to 100 p.p.s., and a logarithmic law from 100 to 10,000 p.p.s. The design of such a condenser has been dealt with elsewhere,† and is both difficult and costly enough even if it is designed in conjunction with the heterodyne oscillator, but becomes practically impossible when applied to existing oscillators, the fixed frequency of which may vary within appreciable limits from one to another.

---

* Comité Consultatif International Téléphonique.

† *P.O.E.E. Journal*, Vol. 27, Part 3, and *Wireless Engineer*, May, 1934.

Hence, a method has been devised whereby any suitable standard condenser may be driven by a motor running at a constant speed, and its capacity law adjusted in the driving links, so that the particular oscillator with which it is associated, produces the required frequency/time characteristic. The adjustable link can be made to correct not only a deviation from normal in fixed frequency, but also differences in the $\frac{L}{C}$ ratios of the high frequency oscillator circuits.

The method employed is shown in Fig. 1, from which it will be seen that a cam driven at constant speed rocks a cam arm, which increases the capacity of the oscillator condenser, the cam being so shaped that the required frequency/time law is fulfilled.

The condenser so driven may be one with semi-circular vanes. This shape of the vanes affords maximum capacity in minimum of operating space, together with maximum rigidity.

In order to ascertain that the application is suitable for any particular condenser, an analysis similar to the following, should be made, although finally the actual cam shape is to be determined by calibration in conjunction with the oscillator and condenser with which it is to be used.

It may be shown that in a heterodyne oscillator:

$F \propto C$ where F = audio frequency

C = increase of capacity required to produce this frequency from the zero beat state.

This is approximate and is true only if the audio-frequency is small compared with the heterodyne frequency.

Suppose F_1, F_2, F_3 are a series of frequencies such that $F_1/F_2 = F_2/F_3 = K$ and θ_1, θ_2, θ_3 are the angles through which the condenser must be rotated to produce these frequencies.

Then assuming the condenser to have a linear law

$$\frac{F_1}{F_2} = \frac{k\theta_1}{k\theta_2} = K \quad \therefore \theta_2 = \frac{\theta_1}{K}$$

$$\frac{F_2}{F_3} = \frac{k\theta_2}{k\theta_3} = K \quad \therefore \theta_3 = \frac{\theta_2}{K} = \frac{\theta_1}{K^2}$$

etc., etc.

The angles can therefore be re-written :—

$$\theta_1, \ \frac{\theta_1}{K}, \ \frac{\theta_1}{K^2}$$

(In the present design $K = \frac{1}{2}$).

Thus, the condenser must describe total angles equal to these quantities in equal intervals of time. The maximum range of the condenser is to be used, i.e., an angular rotation of 180°.

It is difficult to arrange a cam arm which will operate satisfactorily and simply over such a large arc. For this reason, gears are introduced between the cam arm shaft and the condenser shaft, reducing this angle to approximately 60°. Any error due to back lash in cam or gear mechanism is overcome by a coil spring on the condenser shaft, the spring being tensioned so that in the forward or operating part of the travel the cam and gears act against the torque produced by the spring. The same torque gradually returns the condenser to zero frequency position after the forward run is completed, holding the cam arm in close contact with the cam, and thus avoiding unnecessary shock (see Fig. 1).

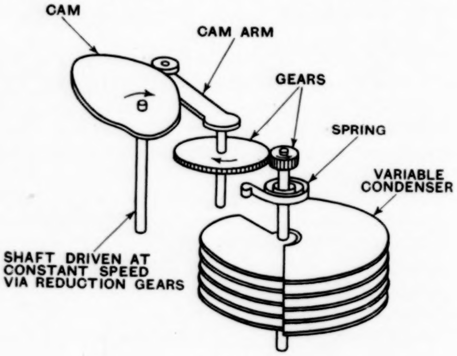
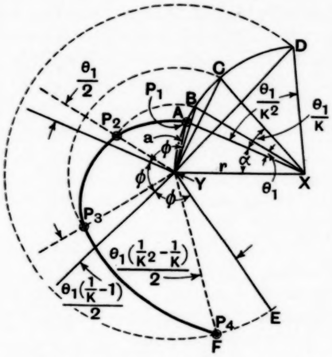


Fig. 1.

Now, the forward travel of the condenser must occupy the time period specified by the C.C.I. for its particular range, i.e., 30 to 10,000 cycles in 113 seconds approximately.

In order to increase the accuracy of the device and avoid delay in the return of the condenser to zero, the forward or operating motion covers the greater part of the cam periphery. Thus the cam can be driven to rotate at uniform speed, one revolution in 180 seconds. Having decided such factors as these, it is now possible to compute the approximate shape of the required cam, as shown in Fig. 2. In Fig, 2 :



$\frac{\theta_1}{2}$
P1
B
A
C
D
$\frac{\theta_1}{K^2}$
$\frac{\theta_1}{K}$
P2
a
ϕ
r
α
X
Y
θ_1
P3
$\frac{\theta_1\left(\frac{1}{K^2}-\frac{1}{K}\right)}{2}$
$\frac{\theta_1\left(\frac{1}{K}-1\right)}{2}$
P4
E
F

Fig. 2.—*Showing graphical method of determining cam shape.*

r = radius of cam arm, centre X

a = radius of cam at 30 p.p.s. (starting frequency)

DXA = total angle of cam arm movement to rotate condenser sufficiently to cover frequency range required (reduced by gearing to condenser)

EYA = total angle through which cam must travel during required frequency range

FYA = angle subtended by operating part of the cam periphery.

For clarity, only 2 intermediate points on the cam are shown :

Let ϕ = angle through which cam rotates, corresponding to equal intervals of time.

Let B and C be the intermediate positions of cam arm.

Then :

$$BXA = \theta_1$$

$$CXA = \frac{\theta_1}{K}$$

$$DXA = \frac{\theta_1}{K^2}$$

From the geometry of the triangles AYX, BYX, CYX and DYX it is obvious that :

$$AYB = \frac{\theta_1}{2}$$

$$BYC = \frac{\theta_1}{2}\left(\frac{1}{K} - 1\right)$$

$$CYD = \frac{\theta_1}{2}\left(\frac{1}{K^2} - \frac{1}{K}\right)$$

The points P_1, P_2, P_3, P_4 on the cam periphery will therefore lie on radii making angles with Ya equal to

$$\phi - \frac{\theta_1}{2};\ 2\phi - \frac{\theta_1}{2}\left(\frac{1}{K} - 1\right);$$

and $3\phi - \frac{\theta_1}{2}\left(\frac{1}{K^2} - \frac{1}{K}\right)$ and on arcs of radii YA, YB, YC, YD. Further, the radii of these points may be computed from :

$$\cos(\alpha + \theta_1) = \frac{2r^2 - a^2}{2r^2}$$

or $a = \sqrt{2r^2(1 - \cos(\alpha + \theta_1))}$

all of which values are known.

This method permits the approximate cam shape to be drawn and examined before a mechanical assembly is made. Having thus determined suitable shapes and dimensions for the cam parts, the assembly may be completed, *less the cam*. The variable condenser is then connected to the oscillator, and its dial calibrated for frequency in the normal way. The blank sheet of metal, from which the cam shape is to be cut, is then attached to the cam shaft so that for pur-

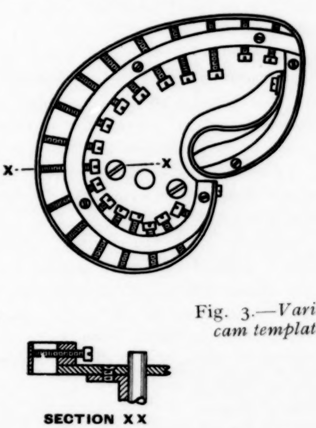


Fig. 3.—*Variable cam template.*

poses of marking its final outline, the cam arm can swing freely above its face. The cam is then set to its zero position, i.e., corresponding to 30 p.p.s. and the cam arm swung over its surface into a position such that the condenser indicates 30 p.p.s. on its dial. The surface of the cam is then scribed tangentially to the running end of the cam arm. The cam is now rotated through an angle equivalent to the time taken to reach 100 p.p.s., the condenser and its cam arm set to 100 p.p.s., and another mark made on the cam surface.

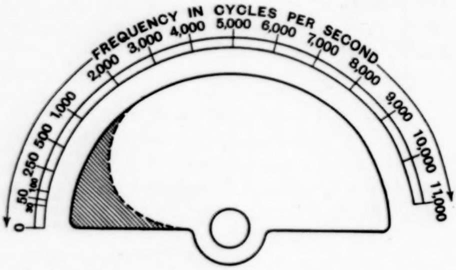


Fig. 4.—*Showing typical vane shape and corresponding frequency calibration (shaded portion cut away).*

This process is continued over as many points as accuracy requires, covering the full range of the condenser. The cam plate is then removed and cut to the shape so marked. If this is done carefully it is a simple process, and, of course, small adjustments may be made when the cam is tried out by trimming its periphery here and there.

To expedite further this process, a "variable" cam has been made consisting of a steel band stretched round the edge of the cam and supported on screws adjustable over a reasonable range (see Fig. 3). This cam is used to obtain the correct cam shape for any particular oscillator and condenser, and then used as a template for the construction of the final cam.

It should be noted here that using a condenser with perfectly semi-circular vanes, inaccuracy is likely to occur at the very low frequencies due to the relatively small angular displacement of the moving vanes per octave. For this reason a standard condenser was modified to have a moving vane shaped as shown in Fig. 4—to comply with no special law, but merely to approximate to a logarithmic law over the early part of its range.

The cam is driven from a "synchronous" self-starting type motor operating from the mains supply. The motor switch is arranged so that the power is automatically switched off when the condenser has completed its forward and return movement.

In parallel with the variable condenser is a fixed condenser c_f (see Fig. 5). This condenser is automatically switched across the H.F. oscillator circuit 6.5 seconds prior to 30 p.p.s. being sent and is of such value that the oscillator output changes from "zero beat" to 1,300 p.p.s. for a period of 1 to 2.5 seconds. During this period contacts m_1, m_2, m_3 are made. After the 1,300 p.p.s. tone period is complete, these contacts break. When the frequency of the oscillator reaches 30 p.p.s., m_2 and m_3 make, remaining made until the range 30 to 10,000 p.p.s. is covered, when they break, thus ensuring that the oscillator has no output while the condenser returns to zero. The output from the heterodyne oscillator is substantially linear with frequency (total variation less than $\frac{1}{2}$ db.) and the output level once set to its proper value remains constant throughout the frequency run.

"Receiving End" Equipment

The receiving end equipment should fulfil the following requirements :—

(1) It should have a linear frequency response characteristic from 30 to 10,000 p.p.s. and an adequate level range.

(2) It should operate from its output a recording meter, the scale of which presents a practically uniform decibel scale over that range.

(3) It should start automatically on a tone of 1,300 p.p.s. at the lowest level likely to be recorded at this frequency. The recording meter should stop automatically at the completion of the "run."

(4) It should have a high impedance input at all frequencies between 30 and 10,000 p.p.s.

Fig. 6 shows the complete schematic diagram of the receiving end recording equipment. Briefly it functions as follows.

The received tone is fed via the first L.F.

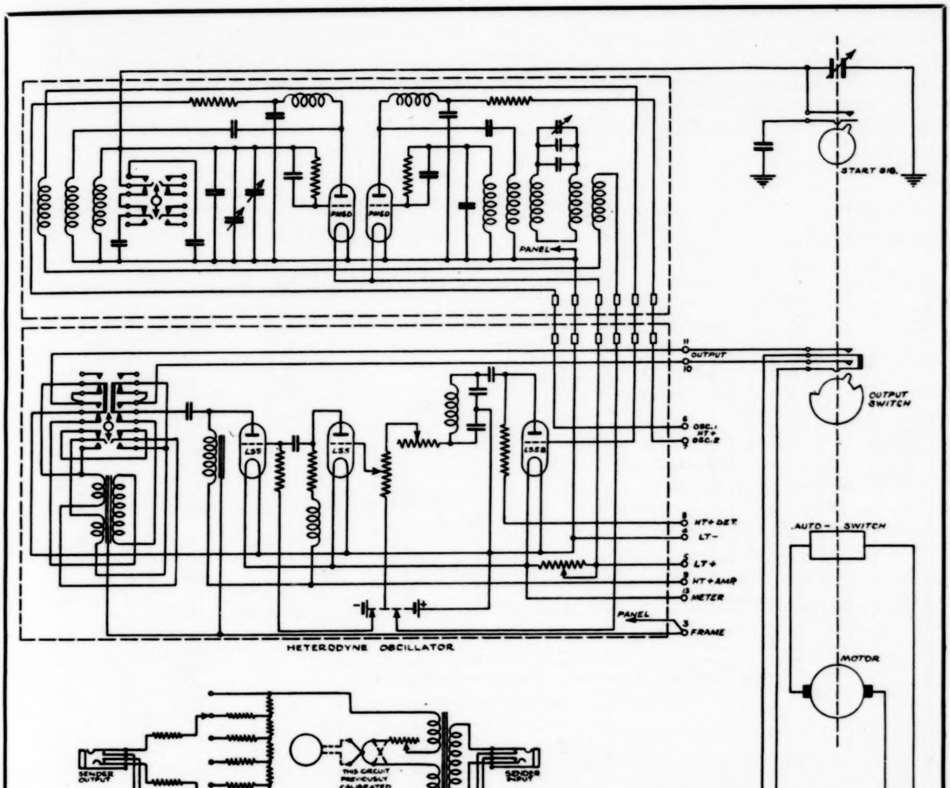

START SIG.
PANEL
PM6D
PM6D
11
OUTPUT
10
OUTPUT SWITCH
6 OSC. 1
HT +
7 OSC. 2
LS5
LS5
LS5B
8 HT + DET.
4 LT −
5 LT +
9 HT + AMP.
13 METER
PANEL
3 FRAME
HETERODYNE OSCILLATOR
AUTO - SWITCH
MOTOR
A.C. MAINS
SENDER OUTPUT
THIS CIRCUIT PREVIOUSLY CALIBRATED ON D.C.
SENDER INPUT
OSCILLATOR AMPLIFIER
O.A. OUTPUT
O.A. INPUT
LOSSPADS
GAIN INPUT
MEASURE LINE
TEST IN
TEST OUT
GAIN OUTPUT
T.M.S. ATT. IN
AMPLIFIER DETECTOR
INPUT
ATT. IN
ATTENUATOR
ATT. OUT
T.M.S. ATT. OUT
TRANSMISSION MEASURING SET

Fig. 5.—*Schematic diagram of sending equipment.*

stage to two metal rectifiers connected in opposite sense across the grid/cathode circuit of the second stage. These rectifiers act as a shunt to the A.C. output from the first stage, one rectifier shunting the positive half-cycle and the other shunting the negative half-cycle.

In practice, the power dissipated in R_1 is insufficient to operate the normal type of recording meter, hence the voltage V_2 is amplified in a linear fashion by subsequent valve stages. The output is then rectified and fed to a standard type D.C. recording milliameter.

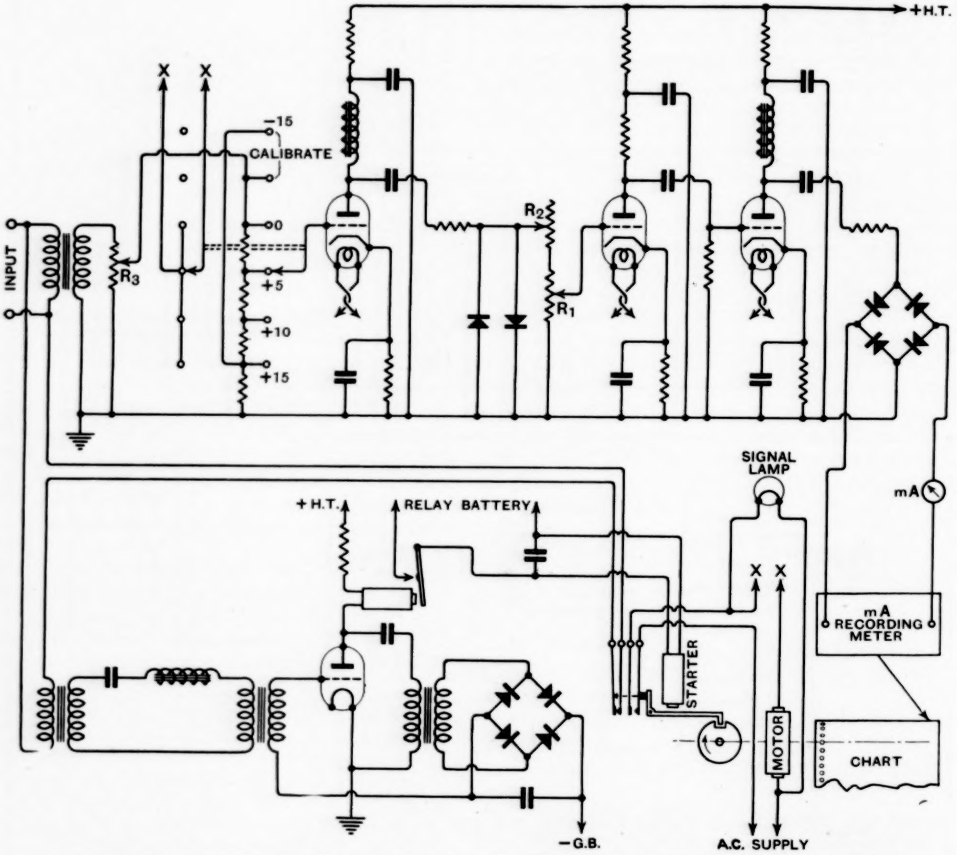


Fig. 6.—*Receiving end schematic diagram. For calibration purposes a transmission measuring set (not shown in this diagram) is used.*

It is well known that metal rectifiers have a non-linear impedance voltage characteristic, particularly at low voltages. If, therefore, rectifiers and resistance values are chosen, such that V_2 is proportional to log. V_1 (see Fig. 7), a meter in series with R_1 would have a uniform decibel scale.

Reverting to the problem of the shunt rectifiers, if (in Fig. 7) R is large compared with R_1, then V_1 will remain unaffected by any change in the shunt rectifier resistance, and the problem may be regarded in terms of the currents in the shunt paths (Fig. 8).

Let :

I_1 = max. input current

I_2 = min. input current

Required to cover the range of N db.

$I_{\text{max.}}$ = corresponding max. current in R_S

$I_{\text{min.}}$ = corresponding min. current in R_S

R_S = resistance of shunt (constant)

R_R = resistance of metal rectifier shunt (variable)

R_{R1} = resistance of metal rectifier shunt at input current I_1

K = constant = $\dfrac{R_{R1}}{R_{R1} + R_S}$

k = constant such that

$$KI_1\left(1 - k \log \frac{I_1}{I_2}\right) \lesssim I_{\text{min.}}$$

At max. input current

Current in $R_S = KI_1$, current in $R_R = I_1 - KI_1$,

To fulfil the correct law for any other current input I

$$\text{Current in } R_S = KI_1\left(1 - k \log . \frac{I_1}{I}\right)$$

$$\text{likewise current in } R_R = I - KI_1\left(1 - k \log . \frac{I_1}{I}\right)$$

$$\therefore \ \frac{R_S}{R_R} = \frac{I - KI_1\left(1 - k \log . \frac{I_1}{I}\right)}{KI_1\left(1 - k \log . \frac{I_1}{I}\right)}$$

$$\frac{1}{R_R} = \frac{I}{R_S KI_1\left(1 - k \log . \frac{I_1}{I}\right)} - \frac{1}{R_S} \ .. \ \text{Eq. (1)}$$

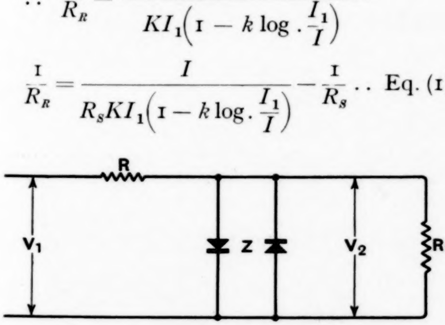


Fig. 7.

Now, the current range in R_S is $I_{\text{max.}} - I_{\text{min.}}$, so that for a decibel range N :—

$$KI_1 - KI_1\left(1 - k \frac{N}{20}\right) = I_{\text{max.}} - I_{\text{min.}}$$

$$k = \frac{20(I_{\text{max.}} - I_{\text{min.}})}{NI_1K} \ \ .. \ \ .. \ \ \text{Eq. (2)}$$

Obviously, the logarithmic current law in R_S can only be obtained over a part of the meter scale (as zero reading = ∞ db.) and in selecting a suitable rectifier such factors as N, $\dfrac{I_{\text{max.}}}{I_{\text{min.}}}$, etc. should be tentatively determined, to be adjusted subsequently to suit any particular rectifier available. Thus assuming any value for R_S and having decided the ranges required, R_R may be plotted against I for different values of K. This will provide a family of curves such as Fig. 9.

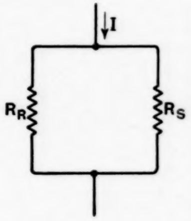


Fig. 8.

Now, if the actual rectifier characteristic is plotted to the same scale (shown by dotted line), by shifting its X axis, the curve with which it most nearly coincides may be found. This gives the value K to be used.

Any shift Y in the X axis indicates that the incorrect value of R_S was originally chosen. The corrected value will be given by :—

$$\frac{R_S \times R_{R1}}{R_{R2}} \ \text{(Fig. 9)}.$$

In the apparatus described in this paper, the rectifiers selected were such that a range of 20 db. was covered in nearly uniform steps of 5 db. per m.A., on a .5 m.A. recording meter. Below 1mA. the scale closes rapidly, the next 5 db. step being covered by .5 mA. approximately. The range of the meter may therefore be said to be 25 db. which is satisfactory for the purpose for which it is required. From the point of view of operating a recording meter there are two ways by which the problem may be approached. The alternating current may first be rectified in a linear fashion and the resulting D.C. supplied to the meter with a suitable non-linear metal rectifier shunt. This method is satisfactory for the non-recording type of instrument, but becomes more difficult when sufficient power has to be supplied to the shunt path to operate a recording meter.

D.C. amplifiers were ruled out owing to their inherent instability with fluctuations in supply voltages, a trouble which is usually overcome by adding a "differential" winding to the moving coil of the meter.

It was therefore decided to utilise the non-linear characteristic of the metal rectifier by shunting the A.C. output from the first valve stage. This considerably reduces the voltage supplied to the next stage, and the second stage was therefore resistance capacity coupled to an output stage, as shown.

The output stage feeds the recording meter direct via a bridge type rectifier. This rectifier must be of such a type that it will deliver current at the correct voltage to operate fully the recording meter. In order that the input/output characteristic may remain linear over the normal operating range of the meter, the A.C. voltage supplied to the rectifier circuit must be considerably in excess of the D.C. voltage output. In other words, the output stage must be designed to supply a resistance load several times greater than the meter resistance. This, of course, is not difficult but must be borne in mind, otherwise the shunt effect of the "log. law" rectifier tends to be neutralised.

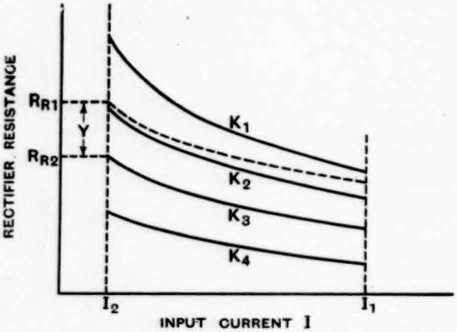


Fig. 9.

It is well known that the resistance of metal rectifiers varies considerably with temperature. In the output circuit any change in the bridge type rectifier is swamped by the anode load of the valve, but the same does not apply in the case of the "shunt" rectifiers. Fortunately, however, this is not such a serious disadvantage as might at first appear. R_S may be made variable so that the correct law between R_S and R_R may be maintained over a reasonable range. Temperature changes in test rooms are not usually appreciable from hour to hour, and again the disadvantage in fairly frequent calibration is not serious if the calibration process is simple.

With reference to Fig. 6, the method of calibration is as follows.

Zero level (0.775-v.) is supplied to the input from the standard transmission measuring set circuit. The input switch is set on the first position, i.e., "calibrate − 15". In this particular case the normal range of the instrument is + 5 db. to −20 db. where − 15 db. is equivalent to 1 mA. on the meter scale. If the meter therefore does not record 1 mA. (in the "calibrate − 15 db." position) the gain of the panel may be re-adjusted by means of R_1. The input switch is now changed to position "calibrate 0 db." and likewise the recording meter should read "4 mA." If it does not, then R_2 is adjusted until the reading of "4" is obtained. On changing the switch back to its first position a small change in the reading of 1 mA. may be noted—small because at low current values the impedance of the metal rectifiers is high—and so the process is repeated until switch positions of "calibrate 0 db." and "calibrate − 15 db." give outputs of 4 mA. and 1 mA. respectively.

Now these are two convenient points on the rectifier characteristic (chosen such that scale variations at any other points are kept to minimum) and are almost independent of each other. Thus, 1 mA. being near the lower limit of the operating range is affected very slightly by large changes in the rectifier resistance (R_R) and really provides adjustment for the gain of the panel as a whole, while the 4 mA. point provides adjustment of $\frac{R_S}{R_R}$ up to a point where this factor is relatively large.

Due to pen-paper friction, it is difficult to read a recording meter unless its paper is running. To obviate this difficulty a small pointer type milliameter has been connected in series with the recording instrument and facilitates panel calibration, etc. R_3 (Fig. 6) is a variable gain control of the preset type, located at the rear of the panel, so that its adjustment, once made to the correct value, is not easily disturbed. The need for such a control will be obvious from the foregoing remarks on the shunt rectifiers. Briefly it provides an adjustment such that I_1 (Eq. 1) may be adjusted initially to the correct value. Obviously, this adjustment is not critical once the correct law of operation is obtained for the metal rectifiers, as it will be seen that it shifts the decibel scale up and down the milliammeter scale.

Further definite scales are provided by the input level switch so that the recorded frequency response characteristic may be arranged to appear on a suitable part of the paper.

The recording meter amplifier, and its associated equipment has been designed to have a frequency response characteristic linear to within 0.5 db. from 30 to 10,000 p.p.s.

The selective circuit for starting the recording meter on 1,300 p.p.s. has been developed from a similar device originally made for selecting voice frequency, ringing tones on line net-works used by the Corporation.

It will be seen that the operating signal reaches the grid of the valve via a resonant circuit, which affords a certain amount of pre-selection, and yet presents a reasonably high input impedance.

The grid of the valve is normally held very strongly negative and in this condition the gain is very small. The valve feeds a series resonant circuit, one member of which is the primary of a transformer. The bridge type rectifier is connected across the secondary of this transformer, so that at resonance a considerable voltage step up is provided to the rectifier. The resultant positive potential is applied to decrease the normal negative bias to the grid circuit.

Now this means that at a critical value of input voltage, the bias will reach the anode bend portion of the valve characteristic. A change in μ occurs and the feed-back effect is suddenly increased causing an abrupt rise in anode current, and thus operating the anode circuit relay. The selectivity and sensitivity of this device are entirely a function of the anode circuit tuning, the final anode current in the state of operation being limited by the anode load resistance. The values may be adjusted so that the sensitive device operates as a band-pass filter.

The relay in the anode circuit connects a battery to the meter starting device (see Fig. 6) which operates, switching on the A.C. supply for the meter motor, and at the same time lifting a pin out of a slot on a disc located on the motor drive. The disc starts to rotate. After the cessation of the 1,300 p.p.s. signal, the meter starting device would restore but is prevented from doing so by the pin on its arm no longer registering with the slot in the disc. The disc is so geared that when the frequency response record is complete and sufficient margin paper has been run out, the slot in the disc again locates opposite the pin, which falls into the slot, thus switching off the recording meter motor.

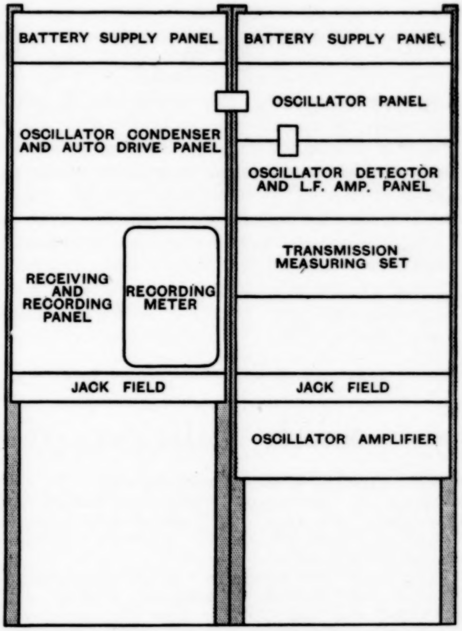

BATTERY SUPPLY PANEL
BATTERY SUPPLY PANEL
OSCILLATOR PANEL
OSCILLATOR CONDENSER AND AUTO DRIVE PANEL
OSCILLATOR DETECTOR AND L.F. AMP. PANEL
TRANSMISSION MEASURING SET
RECEIVING AND RECORDING PANEL
RECORDING METER
JACK FIELD
JACK FIELD
OSCILLATOR AMPLIFIER

Fig. 10.—*Suitable rack arrangement of automatic frequency response recording apparatus.*

On examination of the operating limits set out in an earlier part of this description, it will be seen that the slotted disc will rotate through only a very small arc during the period of the 1,300 cycle signal. In order, therefore, to ensure a clean start, the meter starting relay is shunted by a large electrolytic condenser, thus prolonging its operation some seconds after the cessation of the starting signal.

Further, as the input to the starting circuit is connected across the line, in order to ensure that the input impedance of the recording apparatus remains constant, the meter starting device disconnects its own input, re-connecting it again when the frequency response run is completed.

The need for a high impedance input at the starting frequency is essential, if (as in this particular case) the apparatus is used not only to record the over-all frequency response characteristic of a series of music lines, but to measure the frequency response characteristic at intermediate points. Such routine measurements are essential over a "simultaneous" broadcast line network. The network must have a satisfactory frequency response, not only from one end to the other, but also over its individual links from which the "simultaneous" transmitters are "T"-ed. If, therefore, at the starting frequency intermediate recorders present a low impedance, the loss might be such that the more distant recorders would not operate.

In conclusion, it should be emphasied that such apparatus cannot be expected to operate at great accuracy. Accuracy is limited by such factors as recording paper width, range covered by the recording paper, "shadow" effect due to slight drag of the pen on the chart, variation of oscillator output with frequency, etc. All of these can be reduced to such values that the system may be used to read levels accurate to within 1 db. in a range of 20 db.

This, after all, is amply sufficient to cover the purpose for which it is required—the routine checking of transmission lines and apparatus. Closer investigations may be made at any time by normal manual operation.

Sixth Edition of an American Book

Radio Operating Questions and Answers

By A. R. Nilson and J. L. Hornung. Pp. xiv + 427, 104 Figs. McGraw Hill Publishing Co., Ltd., Aldwych House, Aldwych, London, W.C.2. Price 15s.

This is the sixth edition of a book first published in 1921 and "written specially for students and operators who are about to take the [American] Government examination for a radio operator's licence." "It is assumed that the reader understands radio operating and theory completely and that this book will merely serve to bring out certain salient points as well as to show the general form of answering questions of this kind." "In conclusion, let me caution all applicants who take the radio operator's licence examination to answer all questions fully, never using et cetera to explain a meaning. *Do not be brief.*"

The above gems are culled from the preface to the first edition. The authors do not believe in breaking it gently for the first of the 639 questions is as follows :—

"Ques. 1. Draw a diagram of a Master-Oscillator-Power-Amplifier (MOPA) marine transmitter complete with an audio oscillator, automatic starter, auxiliary and 'A' battery charging equipment, and a vacuum-tube receiver with two stages of audio frequency amplification. State the type and power rating of the transmitter. Label all parts. Explain briefly the parts and the operation of the complete installation."

Having already been warned in the preface not to take the word "briefly" too seriously, the candidate need not allow this to cramp his style.

The model answer to this question occupies 11 pages, but this is exceptional, and many of the subsequent questions are quite short. They cover an enormous range. We can only give a few examples.

"Ques. 51. What is an arc ?"

"Ques. 380. Name three kinds of electricity and give an example of each."

"Ques. 381. What are three ways of telling the presence of electricity ?"

"Ques. 126. What end of the antenna will have the highest potential ?"

"Ques. 195f. Why are springs used in a radio receiver ?"

"Ques. 339a. What is the penalty for attempting to obtain an operator's licence by fraudulent means ?"

We do not like the answer to Ques. 265 : "What is counter e.m.f. in a motor ?" Ans. : . . . "the armature coils cutting through the magnetic field generate a reverse e.m.f. counter to that which set the motor in motion. This back pressure is called the *counter e.m.f. due to self-induction*."

"Ques. 298. What does the United States' law state regarding obscene, indecent, or profane language by means of radio ?"

It will be gathered from these extracts that the book is a mine of information on the technical and legal problems, a knowledge of which is apparently demanded of an applicant for an operator's licence in the United States. That it has reached the sixth edition is a proof that there is a real demand for such a book.

G. W. O. H.

Conditions in the Anode Screen Space of Thermionic Valves*

By H. C. Calpine, B.A.

IN a recent paper[1] Harries has indicated the difficulties of obtaining useful results from a theoretical consideration of the conditions in the screen-anode space of a thermionic valve. The following elementary treatment of potential distribution in a special case of the planar diode seems to provide an approximation to some practical cases and to agree qualitatively with the experimental results.

Consider the unidirectional streaming of electrons normal to two parallel planes, which are maintained at steady potentials V_1 and V_2 both greater than zero. The electrons leaving the first plane have a uniform velocity v_1 where $\frac{1}{2}mv_1^2 = V_1e$, and e is the magnitude of the negative electronic charge. We require to investigate the possible types of potential-distance relations. The fundamental equations are:

$$\frac{d^2V}{dx^2} = 4\pi\rho \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$i = \rho v \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$\tfrac{1}{2}mv^2 = Ve \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Here ρ and i are the magnitudes of the negative (electronic) space charge density and the electron current density respectively.

Eliminating ρ and v we have:

$$\frac{d^2V}{dx^2} = 4\pi i\sqrt{\frac{m}{2eV}} \quad \ldots \quad \ldots \quad (4)$$

and a first integration gives

$$\left(\frac{dV}{dx}\right)^2 = \frac{16K^2}{9}(V^{\frac{1}{2}} - S)i \quad \ldots \quad (5)$$

where S is a constant of integration and we have written

$$K^2 = 9\pi\sqrt{\frac{m}{2e}}$$

Whence $\pm\dfrac{dV}{\sqrt{V^{\frac{1}{2}} - S}} = \dfrac{4K\sqrt{i}}{3} \,.\, dx$

A further integration now yields

$$\pm\sqrt{V^{\frac{1}{2}} - S}\,(V^{\frac{1}{2}} + 2S) = Kx\sqrt{i} + C \quad \ldots \quad (6)$$

where C is another constant of integration. Suppose we take the first plane to be $x = 0$ and the second $x = d$. Then the constants are to be determined from the boundary conditions

$$\pm\sqrt{V_1^{\frac{1}{2}} - S}\,(V_1^{\frac{1}{2}} + 2S) = C \quad \ldots \quad (7a)$$

$$\pm\sqrt{V_2^{\frac{1}{2}} - S}\,(V_2^{\frac{1}{2}} + 2S) = Kd\sqrt{i} + C \quad \ldots \quad (7b)$$

Equation (7a) determines C except for an ambiguity of sign. The value of S corresponding to given values of V_1, V_2, d and i can be found graphically. We plot $y = \pm\sqrt{V^{\frac{1}{2}} - S}\,(V^{\frac{1}{2}} + 2S)$ as a function of S for the particular values $V = V_1$ and $V = V_2$. This gives two curves of the type shown dotted in Fig. 1. The quantities d and i occur only in the product $d\sqrt{i}$ whose corresponding values are then obtained by adding or subtracting the ordinates according to the possible combinations of sign indicated in equations (7a) and (7b).

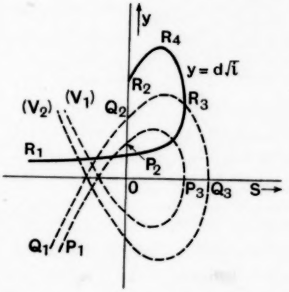


Fig. 1.

---

* MS. accepted by the Editor, July, 1936.

[1] Harries. *The Wireless Engineer* (April, 1936).

Trial will show that the only acceptable solutions are obtained by adding over the portions P_2P_3, Q_2R_3, and subtracting over the portions $P_3P_2P_1$, $R_3Q_2Q_1$. Drawing the corresponding curves, shown full in Fig. 1, we can immediately read off the appropriate value of S for any value of $d\sqrt{i}$. The potential-distance relation is then obtained by substituting this value of S in equation (6) together with the value of C given by (7a) and choosing appropriate combinations of signs.

Let us consider the general form of this relation. Suppose V_1 and V_2 to be fixed, then three régimes can be distinguished. The first includes the region R_1R_3 of Fig. 1, i.e. all $d\sqrt{i}$ less than a certain value. The potential distance curve is here of a simple monotonic type and calls for no comment. The second comprises larger values of $d\sqrt{i}$ (region $R_3R_4R_2$) and the potential distribution now exhibits a minimum. The parameter S has here a special significance. Referring to equation (5) we see that

$$S = V^{\frac{1}{2}} - \frac{9}{16K^2i}\left(\frac{dV}{dx}\right)^2$$

At the minimum $\frac{dV}{dx} = 0$ and therefore if the minimum potential is V_m, $S = \sqrt{V_m}$. We note that if we increase the value of $d\sqrt{i}$, the value of S and therefore of V_m decreases over the portion R_3R_4 of the curve. At a certain stage, however, two possible values of V_m are found for each value of $d\sqrt{i}$, corresponding to points on the portions R_3R_4 and R_2R_4 of the curve. Müller[2] has treated a similar case from the point of view of transit time, and concluded that in those cases in which his equations indicated two possible space charge distributions, the one giving a longer electron transit time was unstable. General energy considerations would also suggest that the conditions corresponding to the portion R_2R_4 of the curve cannot be stably realised. For values of $d\sqrt{i}$ greater than that at R_4, there is no solution for our ideal problem. Evidently our simple treatment does not take account of sufficient factors to deal with this third régime.

The effect of varying V_1 and V_2 while the quantity of $d\sqrt{i}$ is kept constant can be traced in a similar manner from a series of curves such as that given in Fig. 1.

The above analysis might be expected to apply as a first and rather crude approximation to the actual conditions in an anode screen space which is receiving a substantially "saturated" current from the cathode space. It takes no account of the inhomogeneity of the field, and the associated electron-optical aspects of the problem.[3] Neither does it consider the spread of electron energies or the presence of secondary emission from either of the electrodes. It seems plausible to guess that if the secondary emission is not too large, its effect will be to enhance the space charge density and alter the ranges but not the main features of the possible space charge distributions deduced for the ideal case. We proceed, then, on the assumption that the departure of the practical from the ideal case is not so great that it invalidates the general nature of the results. For small screen-anode spacings (d small) we should expect, for the operating range of electrode potentials, a potential curve having either no minimum, or a minimum insufficiently pronounced to prevent the passage of secondary emission. The "dynatron" fold would therefore appear in the characteristic. For larger spacings the decrease in V_m would provide a potential barrier to the secondaries, smoothing out the fold. For very large spacings some other condition would ensue, which, presumably, is represented by the characteristic for a 6 cm. spacing shown in Fig. 1 of Harries' paper. Here the anode current is very small for anode potentials less than 200 v. but thereafter rises sharply to its normal saturated value.

---

[2] Müller. *Hochfrequenztechnik und Elektroakustik* 41 (May, 1933).

[3] For a recent discussion see Rothe and Kleen. *Telefunken-Röhre* 6 (March, 1936).

A Portable Duplex Radio-Telephone*

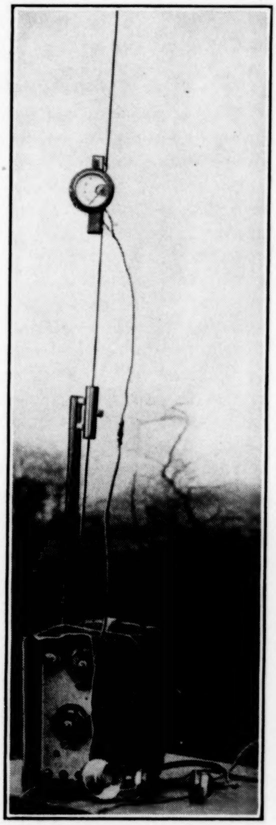
By W. B. Lewis, Ph.D., and C. J. Milner, B.A.

SUMMARY.—A practical system of duplex radio-telephony on ultra-short waves is described in which each set is made alternately transmitter and receiver at a supersonic frequency. The interrupted oscillation provides super-regenerative amplification which is so great that no additional amplification is required, and the sets are therefore simple and may be light in weight. The quench frequency must be selected according to the distance between the sets. Telephony transmission is effected by modulation of the quench oscillator. Since true duplex communication is obtained without appreciable " side tone," one or both sets may be directly connected to an ordinary telephone line.

The theory of the super-regenerative receiver is reviewed and also some practical aspects of the propagation of ultra-short waves.

Attention is directed to the remarkable facility of synchronisation of the quench frequencies even when signals are weak.

THE system to be described provides in the strictest sense a duplex radio-telephone ; that is to say, conversation may pass in both directions at the same time. No manual or voice-operated switches or cut-outs are employed. Further, the radio-telephone may be directly connected at one or both ends to ordinary line telephone circuits. " Subscribers " on these telephone circuits might well be unaware that any radio link was in use.



The duplex radio-telephone set up ready for use.

Introduction

(*a*) *Other Duplex systems*

The great problem of duplex radio-telephony is to prevent the sensitive receiver from being swamped by the local transmitter. Apart from the obvious methods of spacing the receiving apparatus and the transmitting apparatus as far apart as possible, and of using very different wavelengths for the two directions of communication, it appears that two solutions have been put forward. The first is attributed to C. E. Franklin.[1] In this method the local transmitter is made to act as the oscillator of a super-heterodyne receiver, the supersonic beat frequency between this local oscillation and the received signal being then amplified and detected in the usual way. In the second method each apparatus is made alternately transmitter and receiver at a supersonic frequency. The receiver may then employ this interrupted oscillation for obtaining super-regenerative amplification. This principle is adopted in the system to be described.

The idea of using a super-regenerative receiver for *simultaneous* transmission and reception seems to have been put forward first in May, 1928, by G. A. Beauvais.[2] Later in the same year a patent was taken out by Lorenz A.G.,[3] and in 1931 a similar system was patented by the Marconi Company.[4] These early systems appear not to have been ideal. In the Lorenz system there seems to have been difficulty in maintaining synchronism between the quench oscillators at the two sets. From our experiments we expect the Marconi system

---

* MS. accepted by the Editor, March, 1936.

was found to be liable to distortion and background noise.

(b) The Modulated-Quench Duplex System

The apparatus consists essentially of a super-regenerative receiver employing a relatively powerful radio-frequency oscillator quenched at a supersonic frequency by a separate oscillator. The two sets in communication are exactly similar, and the quench frequencies are synchronised. With a suitable circuit it is found that the two quench frequencies lock to one another in a remarkably stable manner. For example, a signal produced by radiating a quenched oscillation of $\frac{1}{8}$ watt average power on 3 metres wavelength from a $\lambda/2$ aerial is sufficiently strong when received on a $\lambda/2$ aerial at a distance of 25 miles, to lock the quench frequency of a similar oscillator with sufficient stability for practical purposes.

When the relative phase of the two synchronised quench oscillations is suitably adjusted, telephonic communication may be established by a *very slight* modulation of the quench oscillator.

Before discussing the detailed working of this system, it seems advisable to review briefly the theory of the super-regenerative receiver,[5, 6, 7] as no very satisfactory account appears to have been published yet in English.

The Theory of the Super-Regenerative Receiver

The super-regenerative receiver consists essentially of a radio-frequency oscillator, the oscillation of which is periodically interrupted or quenched at some high-audible or supersonic frequency. The oscillation is then allowed to build up again, and it is in this building-up process that the amplification occurs.

In one cycle of this quenching process three consecutive states may be recognised, which may conveniently be termed the "quenched," "negatively damped" (or sensitive), and "oscillating" phases. In the "quenched" phase the oscillation dies to zero or more strictly to a residual E.M.F. in the circuit which is only that due to thermal agitation, shot effect, etc., *and* the received signal. This quenched phase is followed by the relatively short "sensitive" phase, in which an oscillation builds up increasing exponentially with time, and the amplitude may therefore be written as A_0e^{kt}. A_0 therefore comprises the random agitation E.M.F. together with the E.M.F. produced by the received signal. When in course of time e^{kt} has reached the value 10 or 100, the received signal is such a small part of the oscillation that any modulation of the received signal would be practically without effect on the increasing oscillation, so we may say that we have passed out of the sensitive phase into the oscillating phase. But it is important to note that the oscillation amplitude is still at any time proportional to A_0, the small received signal and agitation E.M.F. A limit is however reached when A_0e^{kt} is the maximum oscillation which the valve will maintain, $A_{\max.}$ say. Clearly the greater A_0 the sooner this limit is reached and hence the oscillation persists at the maximum for a longer time, assuming that it is cut off at a definite phase of the quench cycle corresponding to the onset of the quenched phase. This is illustrated in Fig. 1. It should be noted that, if the function A_0e^{kt} is plotted against time for different values of A_0, all the curves appear of the same shape but displaced on the time scale. The same proportional change of A_0 produces the same displacement on the time scale whatever the absolute value of A_0.

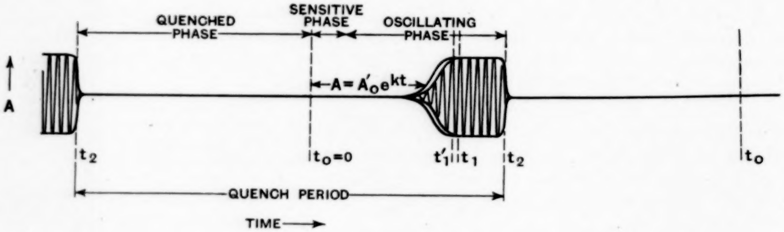
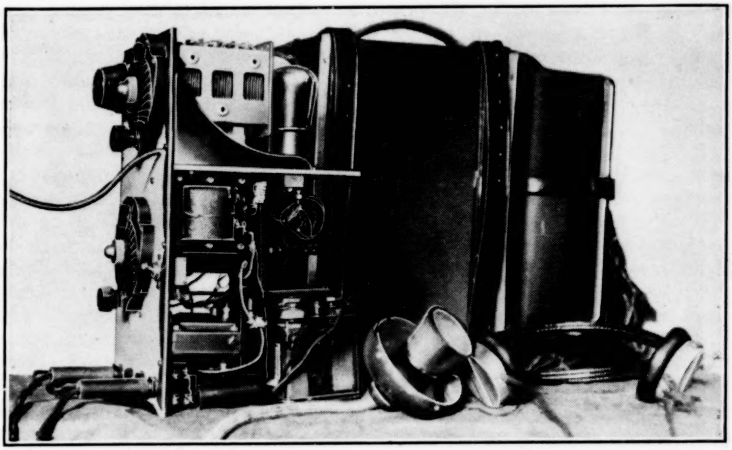


Fig. 1.—*Diagram to illustrate the theory of the Super-regenerative receiver.*

Referring to Fig. 1, the increase of A_0 to A_0' (of the order of 10^{-6} cm. on the vertical scale of the diagram, and therefore quite invisible) due to change of amplitude of the signal reduces the time t_1, at which the oscillation reaches its maximum, to the time t_1'. Quantitatively, $t_1 = -\frac{1}{k}\log A_0 +$ constant, and $t_1' = -\frac{1}{k}\log A_0' +$ constant. Therefore $t_1 - t_1' = \frac{1}{k}\log\frac{A_0'}{A_0}$.



A close-up view of the complete set.

Also the duration of the full oscillation may be written as $t_2 - t_1 = \frac{1}{k}\log A_0 +$ constant. This expression contains the explanation of the remarkable automatic volume control action of the super-regenerative receiver.[5] For if the current in the anode circuit (*i.e.* through the phones) changes by δi in passing from the sensitive phase to the full oscillating condition, then the total current through the phones may be written as $\frac{n}{k}\log A_0 . \delta i +$ constant, where $n =$ quench frequency. The constant current component produces no sound in the phones, the other component is proportional to $\log A_0$. If the received signal is so large that the residual agitation E.M.F. is negligible in comparison, A_0 is proportional to the amplitude of the received signal. If this received signal is modulated we may have $A_0 = A_s\ (1 + m \,.\, \sin \omega t)$ and the current through the phones due to the signal is $\frac{n\delta i}{k}\log A_s \,.\, (1 + m \,.\, \sin\omega t) = \frac{n\delta i}{k}\log A_s$ (which is constant) $+ \frac{n\delta i}{k}\log(1 + m \,.\, \sin\omega t)$. The component due to the modulation is seen to be $\frac{n\delta i}{k}\log(1 + m \,.\, \sin\omega t)$, which is independent of A_s, the absolute signal strength, but depends only on the depth of modulation m. Expressed another way, the loudness of the received modulation depends only on the depth of modulation and not at all on the amplitude of the received signal, and this is true provided that the amplitude of the received signal is considerably greater than the residual agitation E.M.F. in the receiving circuit. It may be noted that this perfect automatic volume control is necessarily accompanied by a slight distortion on normally modulated signals, for $\frac{n\delta i}{k}\log(1 + m \,.\, \sin\omega t)$ may be expanded as $\frac{n\delta i}{k}\left(m \,.\, \sin\omega t + \frac{m^2}{2} \,.\, \sin^2\omega t + \ldots + \ldots\right)$; if m is not greater than $\frac{1}{2}$ $(m \ngtr \frac{1}{2})$, then the distortion terms are $\ngtr \frac{m}{8}(1 - \cos 2\omega t)$.

It is only on short wavelengths that the behaviour of a super-regenerative receiver is in accord with this theory. On longer wavelengths (above about 300 metres) the oscillation does not build up to the full value during the quench cycle, unless the quench frequency is in the audible range. If the oscillation does not build up fully, the automatic volume control action is impaired.

It is characteristic of the super-regenerative receiver that, in the absence of a signal, a rushing noise is heard in the phones. This is clearly due to the oscillation building up from the random disturbance in the circuit. Quite a weak signal of the correct frequency is however sufficient to swamp this disturbance and thus to quieten the background. It will be realised that this effect is due to the automatic volume control action. An exactly similar effect is commonly observed with modern broadcast receivers employing automatic volume control; in the absence of a signal the receiver is most sensitive and brings in background noises. Under some circumstances it might be desirable to apply a system of quiet automatic volume control to reduce the noise in the absence of a signal. Any rational attempt to reduce the background noise when receiving a signal must aim at reducing the random E.M.F. in the oscillatory circuit relatively to the received signal.

It is to be noted that no receiver can be more sensitive than a super-regenerative receiver unless the random disturbance in its first circuit is less than in that of the super-regenerative receiver.

Factors affecting the output of the super-regenerative receiver must be sharply distinguished from those affecting its sensitivity. The output power is proportional only to the change of power dissipated in the anode load between the oscillating and the sensitive conditions, and to the number of interruptions per second (the quench frequency). It is not yet clear how the effective random disturbance in the oscillatory circuit of a super-regenerative receiver depends on the maximum power which may be developed. But it appears that the disturbance does not increase very rapidly with the oscillator power: a powerful oscillator may still be a sensitive receiver. (This is required for satisfactory duplex working.)

From these considerations there is no reason why any audio-frequency amplifier should follow a super-regenerative receiver. It may however be more economical to use a low-power oscillator, followed by an audio-frequency amplifier, than to use a more powerful oscillator.

The amplification provided by a super-regenerative amplifier may be phenomenal, for example a quenched oscillator dissipating from 1 to 4 watts provides amplification of the order of 5.10^8 expressed as the ratio of the audio-frequency output power to the radio-frequency input power, for a wavelength of 3 metres. It should be noted that this amplification is obtained from a single triode valve.

Mode of Operation of the Modulated Quench Duplex System

It has already been mentioned that the quench oscillators of the two sets are adjusted to a common frequency. This frequency and the phase relation between the two quench cycles are so adjusted that the pulse transmitted by one set reaches the other in its sensitive phase, and that the oscillation pulse which then builds up in this receiver and is transmitted, reaches the first set in its sensitive phase.

It will be clear that the adjustment will depend on the distance between the two sets, owing to the time taken by the pulses in transmission over the distance. For example, the performance of two actual sets may be quoted. At distances up to 200 yards any quench frequency in the tuning range, 50 to 100 kc/s., might be used. At from 200 yards to ¼ mile, only the lower quench frequencies could be used. For distances of ¼ to ½ mile a high quench frequency is most suitable. For still greater distances the correct frequency must be found by trial. Having selected the quench frequency according to these rules, satisfactory duplex working may be achieved by adjusting the quench oscillator anode supply, and by a fine adjustment made at one set only of the quench oscillator tuning, keeping within the range over which the quench frequencies remain locked.

When the theory of operation is considered more exactly, it will be realised that it is necessary for a modulated part of the pulse from each set to reach the other in its sensitive phase. Now by the method of modulating the quenching oscillation, the maximum amplitude is only very slightly changed, but the duration of each pulse is changed, *i.e.* the ends of the pulses are modulated. For, as was pointed out earlier, a displacement of the instant at which the oscillation starts to build up is equivalent to a change of the initial amplitude of the oscillation. The same is true of the ends of the pulses: when the set passes from the oscillating to the quenched phase, the amplitude of the oscillation decays exponentially (and very rapidly). A displacement on the time scale is therefore again equivalent to a fractional change of amplitude proportional to the time displacement.

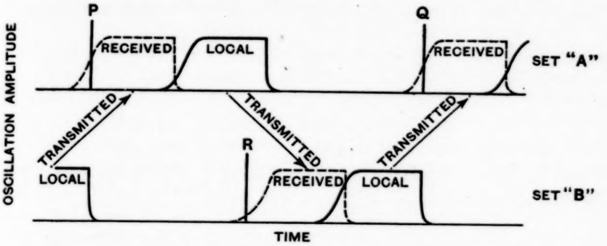


Fig. 2.—*Diagrams indicating performance of the two sets.*

The diagrams of Fig. 2 show the sequence of events at the two sets, *A* and *B*. (It should be noted that the dotted curves of the amplitude of the received signal are *greatly magnified*, until they appear to be of the same order as those of the local oscillation.) Since modulation is effected by displacing the ends of the pulses, the condition for sensitive reception is that the received amplitude should be changing rapidly with time at the sensitive instant of the receiver. This is indicated in the diagrams, where *P* and *Q* are sensitive instants of the set *A*, and *R* such an instant for the set *B*.

A partial explanation of the mechanism of locking of the quench oscillators appears from this figure. As drawn, it shows the set *A* receiving the beginnings of the pulses from set *B*. Should the interval *PQ* be longer than the interval between the received pulses (*i.e.* the quench frequency of set *A* be lower than that of set *B*), then the amplitude at time *Q*, from which the local oscillation starts to build up, is increased: and we have seen that this is equivalent to its having started at an earlier time. The next pulse of set *A* is therefore speeded up, and synchronism tends to be established.

The "local oscillation" of each set is radiated, and becomes the "received signal" at the other: each dotted curve is therefore a replica of the solid curve of the other diagram, but occurs later by the time taken in transmission. It is evident that the instant *R* can only be made to coincide with a part of the dotted curve having a steep slope by suitably choosing the quench frequency with regard to the separation or propagation time-interval between the two sets. Duplex working is therefore only possible with certain quench frequencies, which, when set *A* is being locked to set *B*, allow the sensitive instants of set *B* to occur either at the beginning or end of the pulses received from set *A*.

The duration of the pulses radiated is controlled not only by modulation of the quench oscillator, but also by the received signal. This also follows from the equivalence of a change of initial amplitude and a time displacement of the sensitive instant. The resulting modulation appears to be quite large, and we have found that it may be used to provide a relay action between two sets out of range of one another. When a third set is placed halfway between them, and can "communicate" with each of the others separately, and the quench frequencies of all three are locked together, the three sets can all "hear" one another. Similar "conference" operation is also usually possible when all three sets are able to work to each other in pairs, but the necessary adjustment is difficult and impracticable for mobile sets.

Modulation of the radiated pulses by the received signal is quite efficient compared with that produced by modulating the local quench oscillator. One incidental result of this is that the "side-tone" at the transmitter is perceptibly increased by the re-radiated pulses from the distant station.

Normally the sets are remarkably free from "side-tone," that is to say the speaker scarcely hears his own voice in his receiver. This fact makes it possible to connect the sets to ordinary telephone lines without any trouble from acoustic instability. Alternatively it is possible to use a loud speaker instead of phones for reception without incurring microphone howl.

The Circuit

The circuit of the most successful apparatus used is shown in Fig. 3. The essentials are:

(1) An ultra-short-wave oscillator quenched at a supersonic frequency. This in addition to providing the transmitted oscillation also acts as a super-regenerative receiver. It therefore has a telephone transformer in the anode circuit and, also, in order to obtain a reasonably loud audio-frequency output, the grid circuit includes a resistance of about 50,000 ohms. The automatic volume control action characteristic of this type of receiver makes any additional volume control practically unnecessary.

(2) A speech-modulated supersonic quench oscillator. If the quench oscillation is fed to the grid circuit of the radio-frequency oscillator, the quench oscillator may be of lower power. Further, since only a slight degree of modulation is required, this may be supplied by a microphone and transformer in its grid circuit. The amplitude of the quench oscillation must be adjustable. This is conveniently done by adjusting a variable resistance in the H.T. lead. The frequency of the quench oscillator must also be adjustable over at least one octave, if communication is to be obtained at all distances.

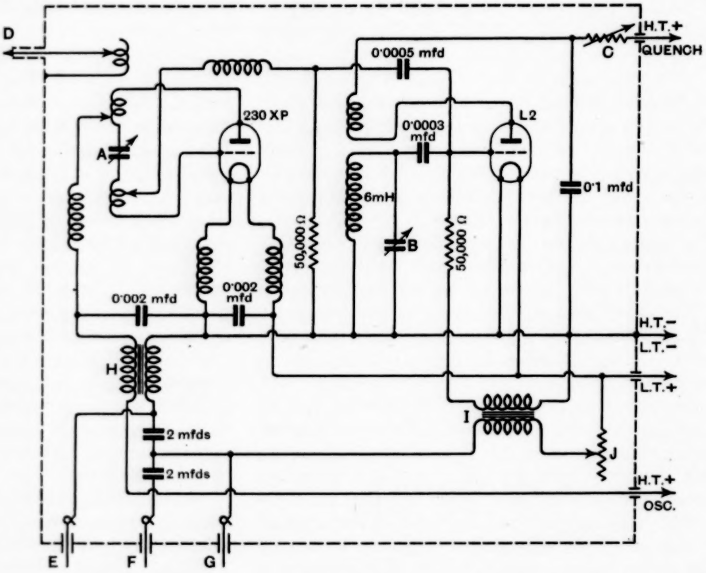


Fig. 3.—*Circuit diagram of the duplex radio-telephone finally adopted by the authors as the most successful tried. The components of the circuit are as follows:—*

A, Radio-frequency tuning 0.0001μF; *B*, Quench-frequency tuning 0.0015 μF; *C*, Quench Amplitude control 50,000Ω; *D*, Concentric feeder to λ/2 antenna; *E*, Ordinary Line connection or L.R. Phones; *F*, Line connection with series condenser or L.R. Phones; *G*, Microphone or Combination Handset; *H*, Telephone Transformer ratio 10:1; *I*, Microphone - Transformer ratio 30:1; *J*, Microphone Sensitivity Control.

It is *essential* that the coupling between the quench oscillator and the radio-frequency oscillator be such that harmonics of the quench frequency may be passed back efficiently from the radio-frequency oscillator to the quench oscillator. If this condition is not satisfied it is in practice impossible to lock the quench frequencies with a constant phase difference. Quench oscillators of the multivibrator type have been tried. These locked more readily, as would be expected, but it was found that they were also less stable against other disturbances, and modulation was not so satisfactory.

In other respects the circuit given may be modified as may be convenient. One or two points may however be mentioned. The radio-frequency oscillator should be as efficient as possible. With ordinary valves the circuit given seems very efficient. In this the filament current is led through a radio-frequency choke in which the two wires are wound parallel on the same core and the wires are bridged by a condenser at the end farthest from the valve. The anode and grid circuit leads are fine wires suitably coiled and coupled to the oscillatory circuit to obtain maximum output. The set is mounted in a screened box to avoid hand-capacity effects, which are otherwise troublesome, especially on the quench tuning. It is very convenient to feed the λ/2 aerial at its mid-point from an untuned concentric type feeder. The outer conductor of this feeder is " earthed " to the screening box, and the feeder is coupled to the oscillatory circuit by a few turns of thick wire adjusted by trial. When connecting the microphone and telephone transformers to a common line, the correct interconnection should be adopted in order to ensure absolute stability. It is also advisable to include a variable resistance in series with the microphone so that the sensitivity may be increased when the set is worked from a long line. The radio-frequency oscillator valve should have a low impedance so that the necessary grid resistance does not cause it to " squegg."

There is another important consideration affecting the choice of this valve. It is found that in general the radiated frequency is slightly higher than the frequency to which the set is most sensitive as a receiver. This seems to be due to a change in the effective inter-electrode capacities of the valve between the oscillating and the sensitive conditions, and depends on the type of valve used. In this respect the Cossor 230 XP has been found the most satisfactory of the small-power valves that we have tried. This valve is also convenient as the leads to the electrodes are short and reasonably thick, so that the external circuit for a wavelength of 3 metres is not inconveniently small.

It will be clear that the reason for adopting the ultra-short waves is that this system occupies a wide frequency band. It is, however, to be noted that as the overall modulation is very slight, the audio-frequency interference is small as long as the quench frequency of the receiver is not locked to that of the interfering transmitter.

The H.T. power supply to our sets is about 20 mA. at 150 volts (3 watts). The aerial current at the centre of the $\lambda/2$ aerial is then about 40 mA. as indicated by a Weston type 425 thermo-milliammeter.

The total weight, including the batteries, need not exceed about 20 lbs.

Performance

The performance of the actual sets may be summarised as follows. Duplex telephony with first-class quality and silent background is obtainable with quite simple tuning adjustments up to a distance of about $\frac{1}{4}$ mile over reasonably open flat ground. Up to this distance a quench frequency of 50 to 60 kc/s. may be used, and communication may be maintained with one set on a moving car without any necessity for altering the adjustment.

At greater distances the quench tuning adjustment depends on the distance between the sets ; and as the signal strength falls off quality becomes marred by increasing background hiss. This is, however, no worse than is observed with an ordinarily modulated transmitter of the same power. At the extreme limit of range, where it might be just possible to catch familiar phrases using a straight transmitter, it is found with the modulated quench system that the quench locking becomes difficult to maintain.

The range obtainable with these sets depends very markedly on the sites chosen. With aerials not reaching more than 6 feet high, the effective range over flat ground is found to be about $\frac{5}{8}$ mile. With favourable sites at the top of steep slopes, however, a greater signal strength has been obtained over 25 miles, and reasonably satisfactory duplex telephony has been carried out at this range.

The disparity between these figures is an instance of the surprising characteristics of the propagation of waves of these wavelengths. The main features of the difference from longer wavelengths are explained on the generally accepted hypothesis, [8 9 10] that (1) these waves are too short to be reflected at all from the Heaviside layer, (2) strong reflection, with reversal of phase, takes place from the surface of the ground. The earth behaves as a dielectric at these frequencies, and (for 3-metre waves at approximately grazing incidence) as practically smooth. If the transmitter and receiver are situated at ground level, therefore, the direct ray and the ray reflected at the ground are received almost exactly out of phase and with equal intensity. There is thus a minimum of signal strength along the surface of the ground. As the sets are raised above the ground, a path difference is introduced between the direct and the reflected rays, and the signal strength is increased. (The strength at a fixed height is proportional to the inverse *square* of the distance, and not to the inverse of the distance, since the path difference is smaller the greater the distance between the sets.)

The best site for an aerial is therefore at the edge of a precipice facing the distant station, or at the top of a high mast or building: not only (as is still commonly supposed) because a more distant horizon is obtained from a height, but also because a path difference is introduced between the direct ray and the ray reflected from the surface of the ground.

It was stated by Beauvais in 1930[11] that it was most unfavourable for transmission if the waves left the transmitter or arrived at the receiver at grazing incidence over the surface of the ground for even a short distance, while the path of the waves might pass for miles over the surface of the earth or sea, midway between the transmitter and receiver, without much attenuation. The waves are, however, rapidly attenuated below the horizon. These conclusions have been substantiated by all subsequent workers. We may quote briefly the results of one or two of our experiments bearing on these points. (It must be emphasised that the super-regenerative receiver is so sensitive that these propagation phenomena are in evidence even with the low power radiated by our sets.)

While signals cannot be received beyond a range of about a mile over flat ground, we have received signals at a distance of 47 miles with the sets at the top of steep hills rising 500 ft. from flat country, one near Folkestone and the other near Eastbourne. In this case intervening hills rose 300 ft. above the line of sight (allowing for atmospheric refraction) for a distance of 2 miles. However, the atmospheric refraction may have been abnormally strong during this test. It is much more certain that diffraction was important when a similar test was made on the Yorkshire moors. Fairly strong signals were received when the transmitter and receiver were well situated at the top of steep hills about 7 miles apart. An intervening table-land rose more than 200 ft. above the line of sight for 3 miles. Signals could *not* be received at the centre of the table-land: it seems certain that this was due to the destructive interference caused by the ray reflected there from the ground.

Trees, buildings, and other objects of dimensions comparable with a wavelength produce very marked standing wave patterns. When an aerial is set up inside a building, it is almost essential to move it to a suitable position which in practice can only be determined by trial. The proximity of trees or buildings is, however, much less detrimental than that of open flat ground.

Conclusion

We have been mainly concerned with the practical aspects of communication on ultra-short-waves with portable sets. Nevertheless, it is hoped that this account may be of interest to those concerned with other aspects, for example the synchronisation of frequencies by radio, and the attainment of true duplex radio-telephony. It may be that the simplicity of the system for working over a fixed range is of more account than its portability. In common with other portable ultra-short-wave apparatus, it is at its best when used for temporary communication in mountainous districts. It seems probable that it will be many years before mutual interference on ultra-short-waves becomes a practical problem in the remoter districts.

References

[1] L. S. Palmer, *Wireless Principles and Practice*, p. 410, Longmans, 1928.
[2] G. A. Beauvais, *L'Onde Élec.*, Vol. 7, p. 206 (1928).
[3] Lorenz, Brit. Pat. No. 312,079 (1928).
[4] Marconi, Brit. Pat. No. 388,213 (see also No. 389,225) (1931).
[5] H. O. Roosenstein, *Hochf:tech. u. Elec:akus.*, Sept. 1933.
[6] H. Barkhausen and G. Hässler, *ibid.* Aug. 1933.
[7] G. Hässler, *ibid.* Sept. 1934, Vol. 44, p. 80.
[8] Trevor and Carter, *Proc. Inst. Rad. Eng.*, Vol. 21, p. 387 (1933).
[9] Schelleng, Burrows, and Ferrel, *ibid.* p. 427.
[10] Englund, Crawford, and Mumford, *ibid.* p. 464.
[11] G. A. Beauvais, *Annales de P.T.T.*, April 1930.

The Industry

THE Instrument Department of E. K. Cole, Ltd., announces the introduction of a micro-wattmeter (Type TF 313) designed for the direct measurement of audio-frequency power from 0.5 to 200 microwatts.

A leaflet is now available from RCA Photophone, Ltd., Electra House, London, W.C.2, describing the RCA cathode-ray Oscilloscope.

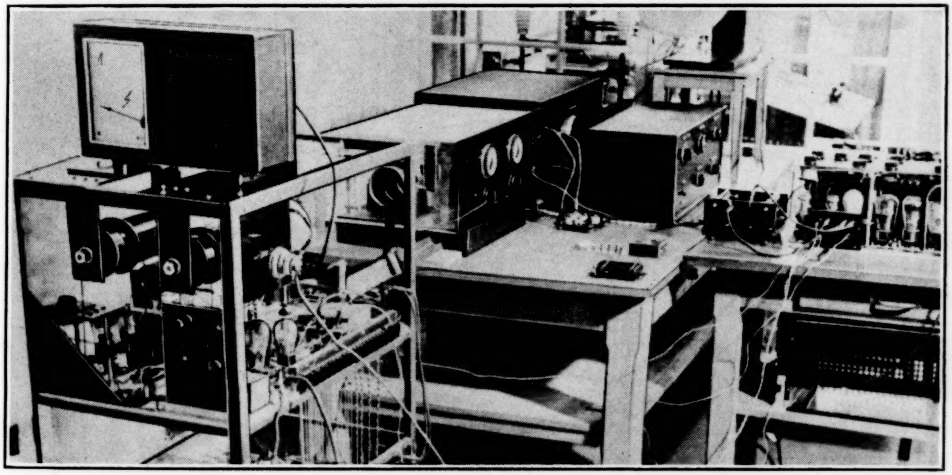
Booklets recently issued by Marconi's Wireless Telegraph Company describe equipment for aircraft and aerodromes, and also telephone terminal and privacy equipments.

High-Voltage Cathode-Ray Tube for High-Definition Film Scanning*

By Manfred von Ardenne

FOR television reception, the old mechanical methods have gone, and the application of electronics to the transmitting end has led to major developments by Zworykin and Farnsworth. There is also the important field of high-grade transmission of film pictures, since they will occupy a large proportion of the optimum hours of programme transmission.

The system uses a transmitting cathode-ray tube with a raster of the highest brilliance, which is sharply focused on to the film, the transmitted light falling into a photo-electric cell. The main difficulty is in the inertia of the cathode-ray tube screen, since the channel must provide a frequency bandwidth of at least 2.10^6 c/s. The author has described† measurements on inertialess screens suitable for 300–400 line scanning, with a spot diameter of 0.3 mm, giving a raster 9 × 12 cm.



Transmitting and receiving apparatus for frequency bands up to 2.10^6 c/s.

The light in lumens falling on the photo-electric cell is

$$L_z = \frac{1}{16} L_r \frac{1}{F^2} \frac{1}{(1 + V)^2} \eta.$$

where L_r is the total light in lumens from the raster, F is the stop of the lens, V is the number of times the height of the raster is greater than the reduced image on the film, and η the transmission coefficient of the film.

Because of the rapidly increasing noise level of the input circuit to the cell amplifier with increase in band width, it is essential to increase L_z as much as possible. Since the limitation of the brilliance of the spot is saturation of the screen, the raster must be as large as possible.

L_r is clearly that part of the illumination which is inertialess. In some early screens, the fluorescent portion of the illumination nearly vanished for high scanning speeds. The material now used has a phosphorescent contribution of only 5% or less, the maximum light emission being near 5,300 Å. The phosphorescent maximum is near 6,200 Å; discrimination can be easily increased by using a photographic filter or, better, using a photo-electric cell with a maximum response near the former figure.

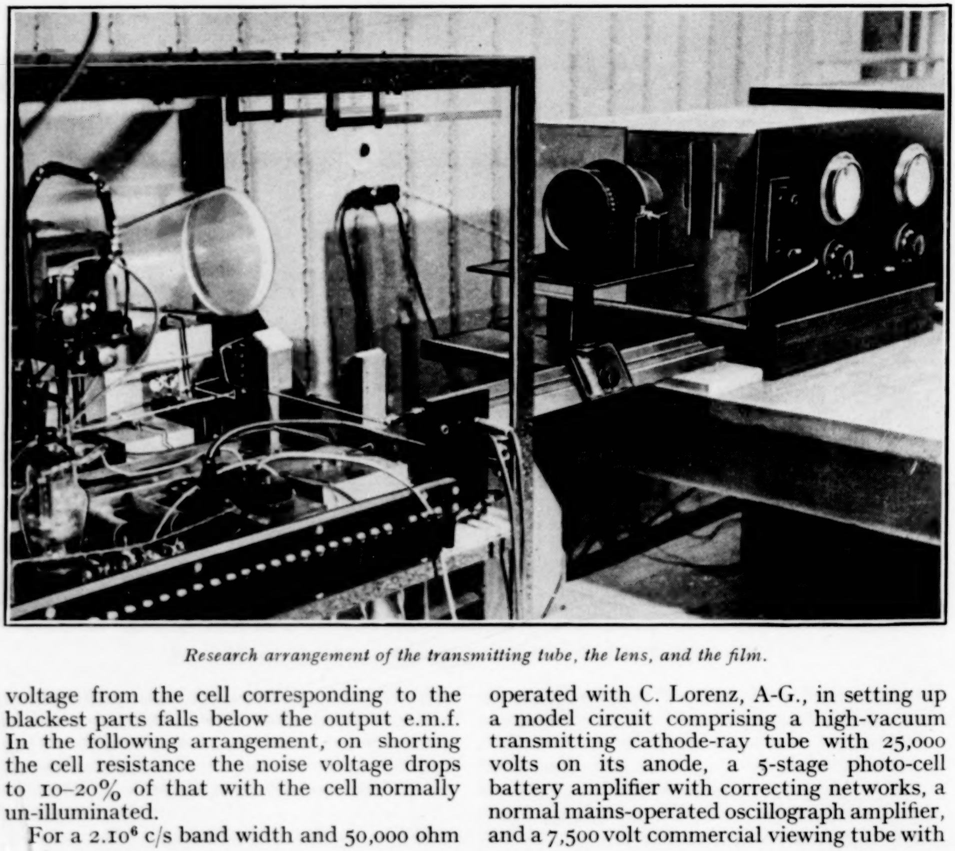
---

* Abstract of article in Fernsehen und Tonfilm, February, 1936, by permission of the author.

† *Zeits. f. Techn. Phys.*, 16, No. 3, 1935.

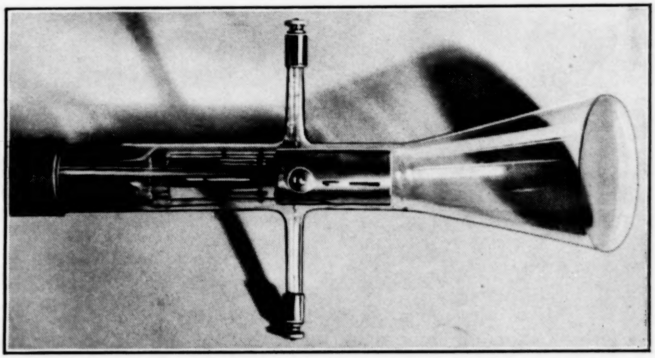
V has a lower limit depending on the possibility of providing an efficient optical system for the required coverage; for standard film, *V* is about 6. The maximum transmissibility of film is 85% for the lightly printed positive suitable for telecine scanning. The print should not be so dense that the voltage from the cell corresponding to the blackest parts falls below the output e.m.f. In the following arrangement, on shorting the cell resistance the noise voltage drops to 10–20% of that with the cell normally un-illuminated.

For a 2.10^6 c/s band width and 50,000 ohm coupling resistance, the noise e.m.f. is 0.4 milli-volt, and the ratio of illumination should not exceed 15/1. The voltage due to maximum illumination then amounts to 6 milli-volts. The effectiveness of an alkali cell for the light used is about 10^{-5} ampere/lumen. Taking into account the input capacity of the cell amplifier, it is necessary to provide 30–50 or more lumens from the raster of the transmitting tube. The alternative to cooling the photo-cell circuit with liquid gas, to reduce the thermal noise and also to retain an adequate light reserve, is to use the principle of secondary emission to amplify the photo currents, a principle which places telecine scanning on an entirely new basis.



Research arrangement of the transmitting tube, the lens, and the film.

For quantitative tests, the author co-operated with C. Lorenz, A-G., in setting up a model circuit comprising a high-vacuum transmitting cathode-ray tube with 25,000 volts on its anode, a 5-stage photo-cell battery amplifier with correcting networks, a normal mains-operated oscillograph amplifier, and a 7,500 volt commercial viewing tube with commercial time-bases, the synchronising being through a local circuit. The oxide coating of the scanning cathode tube proved stable under the high voltage, a feature of the tube being the non-critical adjustment of the accelerating field. The scanning voltages are increased in the same proportion as the anode voltages.



High-voltage transmitting tube, with anode voltage up to 2,500.

At 24,000 volts, 85 lumens illumination was obtained with stability. The lens was f/1.55, $V = 6$, $\eta = 85\%$. The bright portions of the film gave 0.035 lumen to the cell, giving 0.3 micro-ampere, which provides a signal greatly in excess of the noise at 0.4 milli-volt.

Short-Wave Wireless Communication

By A. W. Ladner and C. R. Stoner. Pp. xiv +453. 248 Figs. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 21s.

This is the third edition of this work which first appeared in 1932,* and this fact and the numerous reprintings of the second edition which were necessary show that the book meets a very real demand. Much of the text has been revised and a new chapter on "Commercial Wireless Telephone Circuits" added. The authors have had the assistance of various experts of the Marconi Company in connection with the rearrangement and addition of new material, thus ensuring that this material is accurate and up to date.

The statement on p. 218 that "no energy is required to maintain an electromagnetic wave in a pure dielectric" is, of course, hardly correct; there must be a continual supply of energy to maintain the wave shown in their Fig. 121. This energy is, however, not dissipated in the medium but is transmitted by the wave without loss, and this is presumably what the authors really meant.

The section dealing with the magnetron is not quite up to date, but this is hardly surprising in view of the rapid developments. The statements that "experimental work suggests that efficiencies of 5% are the maximum" and that "there are no troubles due to the heating of internal electrodes" are at variance with recent publications. Something is wrong with Fig. 233 and we disagree with the statement that Fig. 234 is "here very helpful." Most of the illustrations are excellent, but this one is a failure. References are made to the anode voltage curve in Fig. 231 and there is a scale of anode voltages but the curve has been omitted. Lecher is the name of a person and should be written with a capital letter. Every chapter concludes with a useful bibliography and there are a number of appendices dealing with mathematical matters unsuitable for inclusion in the general text.

There is, however, one section of the book which needs serious revision, and that is the section dealing with fundamental principles. The two alleged laws of electromagnetic induction on p. 27 show that the authors are here quite out of their depth. The number of electric lines—using this term in the authors' sense—cutting a circuit per second, multiplied by 4π does not give the magnetic force, but it would, if divided by 3×10^{10}, give the line integral of the magnetic force around the circuit. Similarly the number of magnetic lines cutting a circuit per second is not equal to the electric force but to the line integral of this force around the circuit, with a similar attention to units. The statement that one electrostatic line starts out from every positive unit charge is apt to be misleading unless it is made clear that the lines referred to are lines of displacement and not lines of force; the number of electrostatic lines of force associated with unit charge is $4\pi/k$. If the voltage E across a condenser is divided by the distance d between the plates, the quotient F is not the electric force *per unit length* as stated on p. 27.

It is to be regretted that a book which has reached its third edition, and which contains so much excellent material, should not have had more care devoted to the accuracy of these fundamental sections. Why do so many people discard Faraday and Maxwell and try to invent their own laws of electromagnetic induction?

G. W. O. H.

---

* For reviews of the earlier editions see March, 1933, p. 138, and May, 1934, p. 248.

Nomograms for Symmetrical Attenuation Circuits*

By E. A. Hanney, M.Eng., Ph.D., A.M.I.E.E.

A SHORT telephone line, or a distortionless line of any length, in which attenuation is the same at all frequencies, can be replaced by pure resistances, arranged in symmetrical Tee, Pi, or Lattice connection. Such circuits also form attenuation circuits, which prove useful in many types of measurement. In an artificial distortionless line the values of the resistances are proportional to the " characteristic impedance," and to the values of hyperbolic functions of (ax) ; a is the attenuation constant of the line, and x is the length of the line which is to be replaced by resistances ; the ratio of the line voltages at the two ends of the section of length x is given by ϵ^{ax} ; and the voltage gain expressed in decibels is twenty times the log. (to the base 10) of this voltage ratio. In an attenuation circuit, the resistance R_0 of the apparatus connected to the terminals is the above " characteristic impedance " ; and the combined resistance of the attenuation circuit and R_0 is also R_0 ; in general, values of the resistances are required for a given attenuation in decibels.

Thus the calculation of these resistances is tedious when values are required to produce a certain change, expressed in decibels. The charts which are produced herewith enable the quantities to be estimated fairly closely, over the useful range. Whilst the characteristic impedance R_0 is commonly 600 ohms, it is not invariably so, and a range of 300 to 1,200 ohms is given.

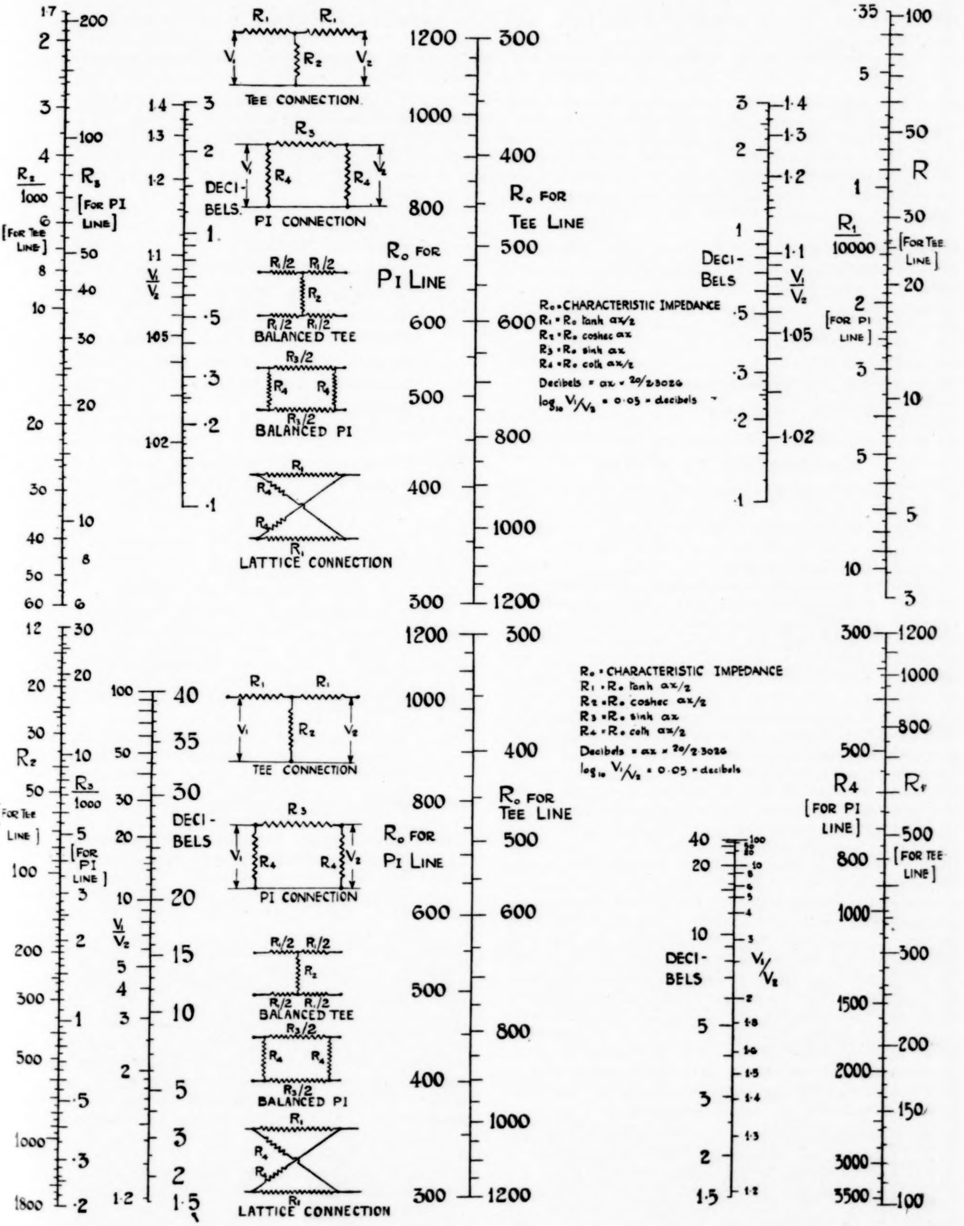
One chart covers small attenuations, from 0.1 to 3 decibels. The other chart covers the range from 1.5 to 40 decibels. Each chart is really two separate nomograms, having a common axis for values of R_0.

Five types of circuit are shown. The scales are marked with values of the resistances for Tee and Pi connections. For the *balanced* Tee and the *balanced* Pi connections, the same resistances are required, but in each case one of the values is halved, and two resistances of this half value are used ; the arrangement is made clear by the small sketches of the connections on the charts. The resistances for the Lattice connection are R_1 and R_4, and care should be observed in finding the values ; thus R_4 is associated with the value of R_0 on the scale " R_0 for Pi Line " ; and R_1 is associated with the value of R_0 on the scale " R_0 for Tee Line " ; or, alternatively, read R_1 and R_4 for $R_0 = 600$ ohms, and then change each resistance in the same ratio as R_0 is changed from 600 ohms.

The information included in the charts makes their use self-explanatory. But for the benefit of those who may not be familiar with the use of nomograms it may be added that a straight-edge laid across any one of the four nomograms, so as to connect a value of R_0 with a value of R_1, or R_2, or R_3, or R_4, crosses the decibel axis at the appropriate value. For example, if an artificial Tee line or attenuator is required, to give an attenuation of one decibel, and to have a characteristic impedance of 600 ohms, the straight-edge at once indicates on one nomogram that R_2 must be 5,160 ohms ; on the adjacent nomogram R_1 is found to be 34.5 ohms ; incidentally, the decibel scale indicates at the same time that the voltage ratio is slightly in excess of 1.12. Finally, for those who will take the trouble, a straight line scribed on celluloid is better than an ordinary straight-edge in reading any nomogram, since the view of the adjacent scale markings facilitates interpolation.

---

* MS. accepted by the Editor, March, 1936.



Attenuation chart. One chart covers small values of attenuation, 0.1 *to* 3 *decibels, whilst the other covers* 1.5 *to* 40 *decibels.*

Abstracts and References

Compiled by the Radio Research Board and reproduced by arrangement with the Department of Scientific and Industrial Research

For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

	PAGE
Propagation of Waves	488
Atmospherics and Atmospheric Electricity	490
Properties of Circuits	490
Transmission	492
Reception	494
Aerials and Aerial Systems	495
Valves and Thermionics	495
Directional Wireless	499
Acoustics and Audio-Frequencies	499
Phototelegraphy and Television	503
Measurements and Standards	506
Subsidiary Apparatus and Materials	508
Stations, Design and Operation	513
General Physical Articles	514
Miscellaneous	514

PROPAGATION OF WAVES

3277. OBLIQUE PROPAGATION OF ELECTROMAGNETIC WAVES IN A SLOWLY-VARYING NON-ISOTROPIC MEDIUM.—H. G. Booker. (*Proc. Roy. Soc.*, Series A, 2nd June, 1936, Vol. 155, No. 885, pp. 235–257.)

Author's summary:—A solution of the Maxwell-Hartree differential equations for any slowly-varying non-isotropic medium is investigated with a view to applying the results to the ionosphere. It is deduced that a plane wave incident upon the ionosphere (not necessarily normally) is in general split up into two magneto-ionic components each of which is propagated independently through the ionosphere. It is shown that the type of propagation experienced by these magneto-ionic components at each height is in general approximately the same as that of the characteristic waves in the homogeneous medium appropriate to that height. It is further shown that each magneto-ionic component is independently reflected from the ionosphere provided the electron density reaches a certain critical value. This value is calculated by expressing the condition that the direction of energy-propagation, and *not* phase-propagation, is horizontal. A method for determining the limiting polarisation of down-coming wireless waves is also investigated, and it is shown that the magneto-ionic components retain their characteristic polarisations down to heights where the difference between their two *complex* refractive indices is of the same order of magnitude as the rates of change of either per wavelength, but that, with further decrease of height, no further appreciable change of polarisation takes place.

3278. PROPAGATION OF ELECTROMAGNETIC WAVES [Calculated Relations for Amplitudes of Components of Reflected Waves with External Magnetic Field].—C. T. F. van der Wyck. (*Nature*, 27th June, 1936, Vol. 137, pp. 1072–1073.) For analogous work without magnetic field, *see* Elias, 1931 Abstracts, pp. 315 and 373.

3279. ELECTRON TEMPERATURE AND DIURNAL VARIATION IN THE F REGION OF THE IONOSPHERE.—J. Fuchs. (*Naturwiss.*, 3rd July, 1936, Vol. 24, No. 27, p. 429.)

The writer finds that the presence of excited atoms in F_2 region, which he has already deduced (2511 of July), requires that the electron temperature there must be higher than that of F_1 region and the recombination coefficient smaller, so that the maximum electron density in F_2 region is attained some hours later than that in F_1 region. The regions are thus distinguished by general differences in height, gas and electron temperature, and electron density.

3280. RADIOELECTRIC INVESTIGATIONS ON THE IONISED UPPER ATMOSPHERE [Survey of Methods, Results and Conclusions].—I. Ranzi. (*L'Elettrotec.*, 25th June, 1936, Vol. 23, No. 12, pp. 350–357.)

3281. IONOSPHERIC HEIGHT MEASUREMENTS IN EASTERN BENGAL BY THE METHOD OF SIGNAL-FADING.—B. S. Gupta, D. N. Chaudhuri and S. R. Khastgir. (*Phil. Mag.*, July, 1936, Series 7, Vol. 22, No. 145, pp. 132–144.)

The signal-fading method is here adapted to a distance at which the down-coming wave is no longer negligible compared with the ground wave. The theory of the method is discussed and the experimental arrangements described. Experimental results are given which include evidence of multiple reflection at E region. The average height was 106 km but was sometimes distinctly greater. There were "strong indications of occasional penetration" of E region by 370 m waves, and of "simultaneous reception of E_1- and F_1-rays," showing a "patchy" nature of E region. The average height of F region was found to be 215 km. *See* also 2517 of July, where "downcoming" and "ground" should be interchanged: the ratio is given wrongly *not* in the authors' summary, as here stated, but in their text, near bottom of p. 138.

3282. Collisional Friction Frequency in the Ionosphere at Allahabad [Experimental Value differs considerably from Values determined in England].—G. R. Toshniwal, B. D. Pant and R. R. Bajpai. (*Nature*, 4th July, 1936, Vol. 138, p. 37.) For theory of method *see* 2158 of 1935 (Appleton); for experimental determinations *see* 1729 (Eckersley) and 3750 (Farmer & Ratcliffe), both of 1935.

3283. Natural Periods of Vibration of Ionised Gases in a Magnetic Field [Theoretical Determination for Cases when Density of Ions is Equal to and Greater than That of Electrons].—T. V. Jonescu. (*Comptes Rendus*, 6th July, 1936, Vol. 203, No. 1, pp. 57–59.)

3284. On the Velocity Distribution of Electrons in Electrical Fields. II.—B. Davydov. (*Physik. Zeitschr. der Sowjetunion*, No. 5, Vol. 9, 1936, pp. 433–448: in German.)

Further development of the work dealt with in 4110 of 1935. The assumption that the free path lengths are independent of the velocities is now done away with, and non-elastic collisions of electrons with gas atoms are now included. *See* also Morse, Allis & Lamar, 24 of January, who however "neglect kT, so that their calculation only applies to the limiting case of strong fields" (*cf.* 3286, below). Formulae for the total number of excitations are given. The order of magnitude of the mutual action between the electrons is estimated, and the condition defined in which this mutual action leads to the establishment of Maxwellian velocity distribution with anomalous high electron temperature far exceeding that of the gas. Finally, the formulae obtained are compared with those obtained from the work of Landau & Kompanejez on semi-conductors (339 of 1935).

3285. Distribution of Energies of Electrons [in Luminous Discharge Columns: Theory of Diffusion: Electron Displacements and Energies: Effect of Collisions].—J. S. E. Townsend. (*Phil. Mag.*, July, 1936, Series 7, Vol. 22, No. 145, pp. 145–171.)

3286. The Energy Distribution of Electrons in an Electric Field in a Gaseous Column [Influence on Distribution Function of Energy Losses due to Impacts with Atoms: Agreement with Morse-Allis-Lamar Distribution, Departure from Maxwellian].—H. C. Kelly. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 861: abstract only.) *See* 24 of January; *also* 3284, above.

3287. Collisions of the Second Kind and Electronic Affinity [elucidated by Measurements of Diminution of Intensity of Slow Electron Beam passed through Gaseous Mixture].—L. Goldstein. (*Comptes Rendus*, 22nd June, 1936, Vol. 202, No. 25, pp. 2057–2059.)

3288. Ionosphere Studies during Partial Solar Eclipse of February 3, 1935.—Kirby, Gilliland and Judson. (*Proc. Inst. Rad. Eng.*, July, 1936, Vol. 24, No. 7, pp. 1027–1040.) *See* 2515 of July.

3289. Short Waves and the Eclipse [of 19th June].—(*World-Radio*, 10th July, 1936, Vol. 22, pp. 12 and 13.)

3290. Radio and the Sunspot Cycle.—L. C. Young and E. O. Hulbert. (*Phys. Review*, 1st July, 1936, Series 2, Vol. 50, No. 1, pp. 45–47.)

Authors' summary:—The observed optimum frequency f for long-distance daylight communication averaged over the year during the period from 1923 to 1936 was found to vary with the yearly average relative sunspot number s according to the relation $f = 7.8\ (s + 12)^{1/4}$. The march of the sunspot curve from 1749 to 1935 suggests the possibility of greater sunspot numbers in coming solar cycles than the value $s = 78$ which occurred at the 1928 maximum. By means of the f, s relation, radio conditions for sunspot numbers from 100 to 160 are calculated.

3291. Abnormal Long-Distance Contacts on Ultra-Short (5-Metre) Waves on 9th May.—(*QST*, July, 1936, Vol. 20, No. 7, pp. 9 and 84.)

3292. Audibility of Districts [and Connection with Aurorae and Magnetic Storms].—Leithäuser: Stoye. (*See* 3371.)

3293.—Small Local Rapidly Periodic Magnetic Fluctuations.—F. Menaw. (*Sci. Abstracts*, Sec. A, 25th May, 1935, Vol. 39, No. 461, pp. 486–487.)

3294. Ionisation Changes in the Highest Atmospheric Layers during Aurorae and Magnetic Storms [studied at Tromsö by Radio Echo Method: Increased E-Region and Decreased F-Region Ionisation].—L. Harang. (*Sci. Abstracts*, Sec. A, 25th May, 1936, Vol. 39, No. 461, p. 561.)

3295. Effect of Oxygen on the Auroral Afterglow [Orange-Red Flash superposed on Blue-Green Glow].—J. Kaplan. (*Nature*, 4th July, 1936, Vol. 138, p. 35.)

3296. Planets help make Weather by Influence on Sunspots [Correlations between Positions of Mercury, Venus and Earth and Number and Positions of Sunspots].—Sanford. (*Sci. News Letter*, 4th July, 1936, Vol. 30, p. 9.) *See* also 1934 Abstracts, p. 556.

3297. Further Evidence for a Lunar Effect on the Ionosphere from Radio Measurements [Effect of Solar Rotation practically Eliminated by Test Arrangements: Pronounced Broadcasting-Wave Field-Intensity Maxima at 95° Hour Angle (Chicago/Delaware) and 150° (Los Angeles/Delaware), with "Surprisingly Large" Intensity Range: Effect on E-Layer Reflections of Short Waves].—H. T. Stetson. (*Science*, 19th June, 1936, Vol. 83, pp. 595–596.)

3298. SERVICE AREAS OF BROADCASTING STATIONS. —A. L. Green. (*See* 3633.)

3299. RADIO TRANSMISSION SURVEY OF OHIO [on 178 and 188 Metres].—Higgy and Shipley. (*See* 3639.)

3300. THE PRODUCTION OF SHORT ELECTRICAL PULSES [Various Devices improving Pulse Shortness and Sharpness].—R. C. Colwell, A. W. Friend and N. I. Hall. (*Phys. Review*, 1st June, 1936,. Series 2, Vol. 49, No. 11, p. 865 : abstract only.)

3301. SIMPLE EXAMPLE OF BORN'S ELECTRODYNAMICS [Behaviour of Field Vectors of Plane Light Wave in Space characterised by Homogeneous Electrostatic Field, and in Uniaxial Crystal : etc.].—Subin and Smirnov. (*Sci. Abstracts*, Sec. A, 25th May, 1936, Vol. 39, No. 461, p. 464.)

3302. STRUCTURE OF LIGHT WAVES [Significance of Singularities in Solutions of Maxwell Equations].—N. S. Japolsky. (*Nature*, 20th June, 1936, Vol. 137, p. 1031.) *See* 3220 of August.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3303. RAIN STATIC [particularly affecting Aircraft : Its Mechanism : Effect successfully reduced by Electrostatically Shielded Loop Aerial : Problems still remaining].—H. K. Morgan. (*Proc. Inst. Rad. Eng.*, July, 1936, Vol. 24, No. 7, pp. 959–963.)

3304. A PHOTOGRAPHIC STUDY OF LIGHTNING [made with Stationary and Moving Films : Progressive Lengthening of Path of Flash : Some Photographs show Leaders preceding Main Flash].—L. B. Snoddy, E. J. Workman and J. W. Beams. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 860 : abstract only.)

3305. THE PROBLEM OF LIGHTNING AT THE INTERNATIONAL ELECTROTECHNICAL CONGRESSES AND CONFERENCES : *also* MODERN STATE OF WORK ON LIGHTNING AND THE PROTECTION OF STRUCTURES AGAINST LIGHTNING STROKES : PARAMETERS OF LIGHTNING AND THE PART THEY PLAY IN CALCULATIONS OF LIGHTNING-PROOF NETWORKS : LIGHTNING PHENOMENA FROM THE METEOROLOGICAL POINT OF VIEW, AND THE PROBABILITY OF PROGNOSIS OF THESE PHENOMENA : *and* SOME INTERESTING HITS OF LIGHTNING.— (*Elektritchestvo*, No. 9, 1936, pp. 10–30 : in Russian.) By a number of different writers.

3306. PREDISPOSITION OF CERTAIN LOCALITIES TO LIGHTNING STROKES [Critical Survey of Existing Theories : Theory (and Experimental Confirmation) that Variation in Soil Conductivity, and not in Air Ionisation, is the Controlling Factor].—I. S. Stekolnikov and V. V. Javorski. (*Elektritchestvo*, No. 8, 1936, pp. 13–19 : in Russian.) For a previous paper *see* 2579 of 1935.

3307. " POINT DISCHARGE IN THE ELECTRIC FIELD OF THE EARTH " [Book Review].—F. J. W. Whipple and T. J. Serase. (*Electrician*, 17th July, 1936, Vol. 117, p. 84.)

3308. WEATHER CHANGES AS INDICATED BY VARIATIONS IN THE EARTH'S MAGNETIC FIELD [Magnetometer a Better Indicator of Bad Weather than Barometer].—E. F. George and Florence Robertson. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 856.)

3309. THUNDERSTORMS AS A CAUSE OF EARTH CURRENTS.—K. Terada. (*Sci. Abstracts*, Sec. A, 25th May, 1936, Vol. 39, No. 461, p. 487.)

3310. A NEW PHOTO-RECORDING INSTRUMENT FOR EARTH CURRENT MEASUREMENTS [Zeiss Loop Galvanometer].—Beck and Bahrdt. (*Bull. Assoc. suisse des Élec.*, No. 13, Vol. 27, 1936, pp. 395–398.) The loop takes up its position of equilibrium in a few tenths of a second.

PROPERTIES OF CIRCUITS

3311. A RADIO-ELECTRIC PROCEDURE FOR THE CALCULATION OF TRANSIENTS [Evaluation of Integrals using Photocell and Pentode]. —A. Blondel. (*Comptes Rendus*, 8th June, 1936, Vol. 202, No. 23, pp. 1881–1885.)

The effect of a sudden introduction of a sinusoidal e.m.f. into a circuit of given indicial admittance is first investigated theoretically, using Cauchy's integral method, and expressions (7) and (8) are found for the real and imaginary parts of the current produced in the circuit. The integrals on the right-hand sides are the expressions for the transients ; to evaluate these, a " radio-electric " integration is suggested of a sinusoidal carrier modulated in proportion to the admittances given by eqns. (5) and (6). Variable potentials proportional to the carrier and to the modulation respectively are applied by means of a photocell to two grids of a pentode ; a coulomb-meter measures the total amount of electricity obtained by integrating the resulting current, and so evaluates the integrals. The method of modulating the photocell is described.

3312. CIRCUIT WITH SELF-INDUCTANCE FOR DETERMINING THE TIME DERIVATIVE OF A FUNCTION REPRESENTED BY AN ELECTRIC CURRENT.—J. Stohr. (*Comptes Rendus*, 6th July, 1936, Vol. 203, No. 1, pp. 60–62.)

A diagram of the circuit is given and the equations governing it are explained. Two identical triodes are set up in opposition, with resistances and inductances in their anode leads. With proper conditions of symmetry, the potential difference between two points in the circuit is found to be proportional to the derivative of the anode current.

3313. A NEW METHOD OF CALCULATION FOR ALTERNATING-CURRENT SYSTEMS [avoiding Use of Imaginary Quantities : Active and Reactive Components treated Separately, followed by Algebraic Addition].—F. J. Rutgers. (*Bull. Assoc. suisse des Élec.*, No. 13, Vol. 27, 1936, pp. 349–355.)

3314. Symbolical Representation of A.C. Power [Use of Complex Operators: Phase Displacements: Single- and Three-Phase Systems: Vector Diagrams for Power: Calculations of Symmetrical Components of Oblique A.C. Systems].—G. Hommel. (*Arch. f. Elektrot.*, 13th May, 1936, Vol. 30, No. 5, pp. 326–337.)

3315. Mutual Inductance [Mesh-Equation Difficulties due to Inadequate Text-Book Definitions: Fundamental Theory, using "Double Suffix" Notation].—J. Greig. (*Wireless Engineer*, July, 1936, Vol. 13, No. 154, pp. 362–364.)

3316. Distribution of A.C. in Some Circuits: Correction.—Livshitz. (*Wireless Engineer*, July, 1936, Vol. 13, No. 154, p. 365.) *See* 2544 of July.

3317. Mechanical, Electrical and Time Parameters of Magnetostrictive Filters.—N. A. Livschitz. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 6, 1936, pp. 689–699.)

For selecting the required signals in multichannel and remote-control systems, filters are employed in which use is made of either electrical or electro-mechanical resonance. In this paper a theoretical investigation is presented of a filter belonging to the latter class and using an oscillating magnetostrictive bar. A detailed mathematical analysis is given of the oscillating processes taking place in such a filter, and by analogy with an equivalent purely electrical circuit the efficiency of operation is determined in terms of the input and output volts. The selectivity of the filter is discussed, and also the optimum duration and spacing of signal impulses. *See* also 3530.

3318. Networks of the "*mm′*" Type.—M. Zimba'isti. (*Scientific Technical Collected Works*, 1935, Electrotechnical Institute, Leningrad, pp. 36–51: in Russian.)

Author's summary:—The paper contains essentially a description of the method of calculating filters of the *mm′*-type and those of higher orders, together with a brief account of the method of obtaining filters of the *m*-type. The paper includes also some general conclusions on the advantages of filters of the types *m*, *mm′*, etc., as compared with filters obtained by the methods of Cauer and Jaumann. The material contained in Zobel's paper [1931 Abstracts, pp. 436–437] is used here to some extent.

3319. On the Transmission Characteristics of Multipole Networks: an Extension of the Transmission Theory.—A. Matsumoto. (*Nippon Elec. Comm. Eng.*, May, 1936, No. 3, p. 260: summary only, in English.)

3320. Expansion of the Reactance Theorem [to calculate Impedance of Two-Terminal Network taking Losses into Account].—T. Inoue. (*Journ. I.E.E. Japan*, April, 1936, Vol. 56 [No. 4], No. 573, pp. 273–276: English summary p. 25.)

3321. The Practical Side of the Calculation of Band Filters for Broadcast Purposes.—Troeltsch and Steinmetz. (*See* 3357.)

3322. Discussion of the "Reply" of H. Frühauf [on Band Filters]: Reply.—Backhaus: Frühauf. (*Hochf:tech. u. Elek: akus.*, May, 1936, Vol. 47, No. 5, p. 173: 174.) For this argument *see* 2546 of July.

3323. High-Pass and Low-Pass Filters [Simple Rules for Design].—A. L. M. Sowerby. (*Wireless World*, 19th & 26th June and 3rd, 10th & 17th July, 1936, Vols. 38 and 39, pp. 610–611, 628–630, 16–17, 42–43 and 68–70.)

3324. "On Oscillations."—B. van der Pol. (At Patent Office Library, London: Cat. No. 76 319: 36 pp.)

3325. Current Harmonics in Non-Linear Resistance Circuits: Discussion.—Owens. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, p. 837.) *See* 56 of January.

3326. On the Barkhausen-Möller Methods of Analysis and the Strict Theory of Auto-Oscillations.—A. E. Bezmenov. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 467–473.)

A theoretical discussion is given of approximate methods for analysing auto-oscillating systems, in which use is made of such conceptions as the oscillating characteristic, average slope, quasi-linearity, etc. In the present paper the operation of a valve oscillator with inductive back coupling (Fig. 1) is examined, and the building up of the oscillations, their final amplitude and conditions of stability are all determined from the standpoint of exact mathematical theory. The results so obtained are then compared with those derived from the use of the approximate methods proposed by Barkhausen, Möller and Joos.

3327. On Self-Excitation and Resonance in a System with Periodically Varied Inductance.—M. Divil'kovski and S. Rytov. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 474–482.)

If the inductance or capacity of an oscillating circuit is varied with frequency approximately twice the natural frequency of the circuit, oscillations of approximately the natural frequency will appear in the circuit. This phenomenon, called "hetero-parametric excitation," is examined in the present paper, both theoretically and experimentally, for a circuit with varied inductance. A number of oscillating current curves for various operating conditions are given, and the conditions for the appearance of stable oscillations are established. The question of resonance is discussed in detail, and the theoretical resonance curves are compared with those obtained experimentally.

3328. On Auto-Parametric Excitation.—V. V. Migulin. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 6, 1936, pp. 644–661.)

A large number of papers have been recently published in which the operation of valve oscillator systems with one degree of freedom is studied for cases in which a harmonic e.m.f. of a frequency different from the natural frequency is applied to such systems. The author suggests that a common basis can be found for the various interpretations put forward, if these phenomena are regarded as particular cases of auto-parametric excitation in which the parameters and, therefore, the frequency of the system are varied internally and not by some external means as in the case of hetero-parametric excitation (*see* 3327, above). The more important cases are then examined from this point of view and certain general conclusions reached. These have been verified experimentally.

3329. Auto-Oscillatory Circuits governed by Functional Equations [of the Form $I_n = \Phi(I_{n-1})$: exemplified by Circuit of Loudspeaker exciting a Microphone whose Amplified and Rectified Output is taken to Grid of Valve Oscillator which is exciting the Loudspeaker].—V. Bovsheverov. (*Physik. Zeitschr. der Sowjetunion*, No. 5, Vol. 9, 1936, pp. 529–532 : in French.) Lémeray's graphical method is used to solve this functional equation. Another example is found in a parallel-wire line connected in a certain manner to a triode.

TRANSMISSION

3330. Modes of Oscillation in Barkhausen-Kurz Tubes [Experiments on Clavier Resonating-Grid (Helical-Grid) Valve : Development of New Design differing in having Cylindrical Plate in Three Sections independently connected to External Circuit : Frequency Stabilisation by Resonant Lines : etc.].—W. D. Hershberger. (*Proc. Inst. Rad. Eng.*, July, 1936, Vol. 24, No. 7, pp. 964–976.)

For Müller's paper, with which the present results are in general accord, see 1803 of 1935 ; for Clavier's paper here referred to *see* 1934 Abstracts, p. 33. "The evidence afforded by the present design serves in particular to emphasise the importance of the end portions of both grid and plate when the tube is oscillating in the mode for which the grid resonates. In this mode the tube may be viewed as a frequency 'doubler' whose operation is in some respects analogous to that of a conventional full-wave rectifier. The fundamental driving frequency, which may be detected as a relatively feeble oscillation, is given by the Barkhausen law. The strong second harmonic oscillation arises from distortion in the system accentuated by the resonant grid. Under these circumstances the second harmonic is the predominant one."

3331. The Generation of Continuously Variable Micro-Waves by Triodes with Large-Diameter Anodes.—Pierret. (*See* 3384.)

3332. Parallel-Plane Diode Magnetron [Experimental Evidence of Occurrence of Oscillations].—D. M. Tombs. (*Nature*, 4th July, 1936, Vol. 138, pp. 36–37.) For theoretical discussion *see* 985 of 1935 (Benham).

3333. Five-Metre Radio Telephone [Portable Transceiver].—D. R. Parsons. (*Wireless World*, 17th July, 1936, Vol. 39, pp. 50–52.)

3334. Crystal Control for Decimetre Waves.—H. Straubel. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, pp. 152–154.)

For previous work *see* 1740 of May ; *see* also Kühnhold, 72 of January. The stabilisation of 40 cm waves requires special care in the placing of the crystal, and this is here described. The circuit for crystal control of a Barkhausen valve is shown in Fig. 2, where the crystal is in direct circuit between grid and anode. Figs. 3 and 3a show the circuit for crystal control of a magnetron. The oscillation curves with and without crystal are given in Fig. 4. "The stabilised magnetron permits of reception with a single audion, giving small working voltages and therefore small weight at the receiver."

3335. Frequency Stabilisation of Ultra-Short-Wave Oscillators [particularly the Use of Quartz Crystals].—A. Wertli. (*Bull. Assoc. suisse des Élec.*, No. 13, Vol. 27, 1936, pp. 366–368 : in German.)

3336. A Constant Frequency Oscillator with Convergent Frequency Stability Characteristics, and a Stabilised Oscillator without Output Reduction.—T. Hayasi. (*Nippon Elec. Comm. Eng.*, May, 1936, No. 3, pp. 185–191 : in English.)

The first type described employs a low stabilising resistance in which only the a.c. component of the plate current is allowed to flow (3385 of 1935) : it possesses "an interesting feature believed to be as yet unheard of," a convergent frequency-stability characteristic. The second type uses a Meissner circuit with the addition of inductances in plate and grid circuits, with mutual inductance between them but screened from the main coils. It has the advantage of an entirely un-reduced output but is not so stable as the first type. Both types are claimed to have a number of advantages over the usual circuits : with the first type the stability is within about 1 part in 10^5 down to a 40% drop in plate voltage or for a change of ± 15% in filament voltage.

3337. Equilibrium of Vector Power and Problems of Frequency Stability in Self-Maintained Oscillator Systems.—R. Usui. (*Journ. I.E.E. Japan*, April, 1936, Vol. 56 [No. 4], No. 573, pp. 286–292 : short English summary p. 26.)

"Hysteresis loop area and harmonic content in the non-linear characteristic are considered together with the circuit damping constants in vector power continuation, for the determination of the amplitude and the frequency in self-maintained oscillator systems. Groszkowski's and van der Pol's methods are extended for $\oint \Phi(e)\, de \neq 0$, and for several non-linear elements in the oscillating system. The transient frequencies are also considered in connection with the integration method of determining the elongation of oscillation period previously studied by the author. In this paper a fundamental theory of constant-frequency oscillators is established."

3338. PROBLEMS OF DEGREE OF SELF-MAINTENANCE, AMPLITUDE, POWER AND EFFICIENCY OF TRIODE OSCILLATORS.—R. Usui. (*Journ. I.E.E. Japan*, April, 1936, Vol. 56 [No. 4], No. 573, pp. 276–285: short English summary p. 26.)

"Triode oscillators with back couplings are studied analytically, starting from the fundamental differential equation originally studied by the author. Amplitude, power and efficiency are investigated most rationally by the aid of the degree of self-maintenance for all operating conditions, in which a simple dynatron characteristic is assumed. Operating characteristic charts are prepared which allow rough and yet ample speedy estimations of amplitude, power and efficiency at the same time."

3339. SIMPLIFYING THE PUSH-PULL-PUSH CRYSTAL OSCILLATOR.—J. S. Brown. (*QST*, July, 1936, Vol. 20, No. 7, pp. 10–12 and 84.) For the original paper *see* 2234 of 1935.

3340. COLLINS TRANSMITTING EQUIPMENT TYPE 45A, 9–200 M, GIVING 40 WATTS IN AERIAL FOR TELEPHONY AND 125 WATTS FOR TELEGRAPHY.—Billaudot. (*Génie Civil*, 11th July, 1936, Vol. 109, p. 48: summary only.) Mains-driven, crystal-stabilised: using the Collins aerial system (1934 Abstracts, p. 205).

3341. MULTI-FREQUENCY RADIO TRANSMITTER [Any of Ten Frequencies selected by Dialling One Digit on Ordinary Telephone Dial: 300–400 Watts Output: 2–18 Mc/s: Crystal Control].—J. B. Bishop. (*Bell Lab. Record*, July, 1936, Vol. 14, No. 11, pp. 350–354.)

3342. MODERN METHODS OF MODULATION.—Loeb. (*Electronics*, June, 1936, Vol. 9, No. 6, pp. 40 and 42.) *See* 1745 of May.

3343. MODULATION WITH VARIABLE CARRIER AMPLITUDE.—H. Harbich, F. Gerth and L. Pungs. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, pp. 141–147.)

A discussion of the fundamental principles of modulation when the carrier amplitude is adjusted to the depth of modulation. The theoretical basis of the emission (§ I) and the scheme of the circuit employed (§ II, Fig. 4) are first shortly described. The effect at the receiver is dealt with in § III; it is found that "by suitable matching of the carrier amplitude curve to the receiver characteristic, increase of 'klirr' factor and change in the ratios of signal strengths of loud and soft passages can be rendered unnoticeable." This leads to the "residual current" method of minimising the subjective effects of changes in the ratios of signal strengths. Fig. 6 illustrates the construction giving the residual current value required for a given receiver characteristic. Transient phenomena are also considered (§ IV). In § V energy relations are discussed; it is shown that the economies in current cost, and the absence of undesirable effects at the receiver, justify the use of this type of modulation from a practical point of view.

3344. MODULATION METHOD USING MULTIPLE-GRID VALVES [Cophasal Modulation of Screen Grid and Anode: Linear Modulation Characteristic given by Non-Linear Relation between Anode and Grid Modulation Voltages].—J. Rohnfeld: Telefunken. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, p. 175: German Patent 623 602 of 26.10.1933.)

3345. ARRANGEMENT FOR SMOOTH KEYING OF MULTIPLE-STAGE MODULATED EMITTER [Depth of Modulation during Keying regulated by Aerial Current or Anode A.C. Voltage].—W. Buschbeck: Telefunken. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, p. 175: German Patent 622 512 of 4.8.1934.)

3346. THE COMPENSATION OF NON-LINEAR DISTORTION [in a Radiotelephone Transmitter, due to Lower Bend of Modulation Characteristic].—A. Riskin. (*Scientific Technical Collected Works*, 1935, Electrotechnical Institute, Leningrad, pp. 20–29: in Russian.) Including the Lorenz bias-compensation scheme and the writer's method of excitation-compensation, with design and experimental data on the latter.

3347. ON FEED-BACK MODULATION [Elimination of Non-Linearity due to Lower Bend of Valve Characteristic, and to Saturation Effects, by Simple Compensation Method consisting of Combination of Positive Feed-Back Action with Automatic Bias: Side-Band Power Increased].—M. Kamada. (*Journ. I.E.E. Japan*, April, 1936, Vol. 56 [No. 4], No. 573, pp. 293–297: short English summary p. 27.)

3348. A "NEON-STICK" VISUAL MODULATION MONITOR.—C. A. Campbell. (*QST*, July, 1936, Vol. 20, No. 7, pp. 21 and 70, 74.)

3349. "INDUCTIVE" NEUTRALISATION OF R.F. AMPLIFIERS [Neutralisation by Bridge Circuit in which a Mutual Inductance is varied to perfect the Balance: Application to Transmitting Circuits: Advantages].—L. M. Craft and A. A. Collins. (*QST*, July, 1936, Vol. 20, No. 7, pp. 22–24 and 86.) *See* also *ibid.*, p. 44 (Blackburn).

3350. RECENT DEVELOPMENTS OF THE CLASS B AUDIO- AND RADIO-FREQUENCY AMPLIFIERS [and the Reduction of Distortion: Low Impedance Driver System and Tailing-Off Plate-Current Valve Characteristic required: Theory and Experimental Confirmation].—L. E. Barton. (*Proc. Inst. Rad. Eng.*, July, 1936, Vol. 24, No. 7, pp. 985–1006.) The full paper, a summary of which was referred to in 2980 of 1935.

3351. THE PRODUCTION OF SHORT ELECTRICAL PULSES.—Colwell, Friend and Hall. (*See* 3300.)

RECEPTION

3352. Reception in the Micro-Wave Range [Summary of the Various Principles for Construction of Receivers: Illustrative Example describing Frequency Ranges in Heterodyne Method].—E. C. Metschl. (*Naturwiss.*, 10th July, 1936, Vol. 24, No. 28, pp. 433–437.)

3353. Ultra-Short-Wave Converter.—W. T. Cocking. (*Wireless World*, 24th July, 1936, Vol. 39, pp. 74–77.)

3354. $2\frac{1}{2}$ to 555 Metres [Receiver with "Straight" Reception with Regeneration down to 15 m, then switched to Super-Regeneration].—(*World-Radio*, 17th July, 1936, Vol. 23, p. 14.) From an article in *Radio World.*

3355. A [German] Short-wave Receiver for the Tropics.—(*World-Radio*, 17th July, 1936, Vol. 23, p. 14.)

3356. What the Europeans are Doing [Survey of European Receiver Types, Prices, etc., as compared with American].—L. M. Clement. (*Broadcast News*, April, 1936, No. 19, pp. 2–3 and 26, 29.)

3357. The Practical Side of the Calculation of Band Filters for Broadcast Purposes.—F. Troeltsch and J. Steinmetz. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, pp. 156–164.)

This paper aims at giving lucid formulae and curves for the calculation of two-circuit broadcast filters, with special attention to asymmetry. The parabola representation of Feldtkeller and Tamm is used (105 of January and 2992 of August), with the equivalent circuit of a band-filter stage shown in Fig. 1. Formulae for selectivity (eqn. 9), band width (eqns. 12), dip in response curve (eqn. 14), output voltage (eqn. 15) and asymmetry (eqn. 16) are given in § Ib. The permissible degree of asymmetry is discussed in § Ic from considerations of the "klirr" factor (Fig. 6). § II describes the connections between the theoretical parabola constants and the circuit elements of the most common filters. The practical use of the formulae and curves given is illustrated by some numerical examples.

3358. High-Pass and Low-Pass Filters.—Sowerby. (*See* 3323.)

3359. Variable-Selectivity Development [Variable Coupling in I.F. Transformer: Careful Attention to Details necessary: Importance of Efficiency of Coils: etc.].—W. T. Cocking. (*Wireless World*, 3rd and 10th July, 1936, Vol. 39, pp. 2–4 and 31–32.)

3360. A Novel "Signal Booster" [Pre-Selector Unit for Existing Short-Wave Receiver].—(*World-Radio*, 17th July, 1936, Vol. 23, p. 14.) From *Radio News.*

3361. Noise-Suppression in the Receiver: a New American Development [Receiver paralysed for Duration of Each Noise Impulse].—W. N. Weeden: Lamb. (*Wireless Engineer*, July, 1936, Vol. 13, No. 154, pp. 365–369.) For Lamb's papers on this "silencer" *see* 2162 of June and back references. "It would seem [to the present writer] the most important step since the introduction of the superheterodyne or, perhaps, the screen-grid valve . . ."

3362. Low-Interference Broadcast Reception by Communal Aerials.—Schindler and Schneider. (*See* 3374.)

3363. Electrical Interference [Comments on I.E.E. Committee Report].—(*Wireless World*, 24th July, 1936, Vol. 39, p. 77.)

3364. "La nouvelle Réglementation des Perturbations électriques" [Control of Broadcast Interference: Book Review].—J. Isoré. (*Génie Civil*, 11th July, 1936, Vol. 109, p. 52.)

3365. The Prevention of Broadcast Interference due to Bracket Insulators [Suppression of Discharge between Conductor-Binding and Neck Groove by Burnt-On Metallic Coating].—Hescho Company. (*Zeitschr. V.D.I.*, 13th June, 1936, Vol. 80, No. 24, p. 750.)

3366. Grid-Bias Scheme eliminates Feed-Back Trouble [Prior Claim and Additional Information].—W. B. Savage: Richter. (*Electronics*, June, 1936, Vol. 9, No. 6, p. 42.) *See* 2154 of June.

3367. Remarks on Automatic Volume Control [Survey of Modern Methods].—H. Zimmer. (*Funktech. Monatshefte*, June, 1936, No. 6, pp. 203–206.)

3368. Rotary Potential Dividers in Broadcast Receivers.—A. Schöne and H. Ader. (*Funktech. Monatshefte*, June, 1936, No. 6, pp. 201–203.) From the Siemens & Halske laboratories.

3369. The Audio-Frequency Discriminator [giving Amplitude Control of Individual Octaves in Range 20–10 000 c/s: for connection between Detector and A.F. Stage in Broadcast Receivers]—M. A. McLennan. (*Broadcast News*, April, 1936, No. 19, pp. 8–9 and 24, 25.)

3370. "Automatic Tuning" Principle applied to Frequency Sweep for Receiver and Loudspeaker Testing, etc.—Hill. (*See* 3515.)

3371. Audibility of Districts.—G. Leithäuser: Stoye. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, pp. 174–175.) Remarks on the paper by Stoye suggesting a correlation between his reception tables and the occurrence of aurorae and magnetic storms (1697 of May: *see* also 1696.)

3372. Class C Audio System for reducing Interference with C.W. Telegraphy [Filling-Up of Spaces, resulting from Extreme Selectivity of Crystal-Filter I.F. Circuit, countered by Distorting Effect of Class C Amplifier with Adjustable Bias].—N. Bishop. (*QST*, July, 1936, Vol. 20, No. 7, pp. 39–40.)

3373. An Amplifier for Radiotelegraphic Reception.—G. Ostroumov. (*Scientific Technical Collected Works*, 1935, Electrotechnical Institute, Leningrad, pp. 52–59 : in Russian.) With " many advantages over the usual amplifiers."

AERIALS AND AERIAL SYSTEMS

3374. Low-Interference Broadcast Reception by Communal Aerials.—H. Schindler and O. Schneider. (*E.T.Z.*, 9th and 16th July, 1936, Vol. 57, Nos. 28 and 29, pp. 801–804 and 829–831.)

Leading to the quantitative treatment of a communal-aerial system suitable for 4 or 5 subscribers (without amplifier), and one for from 20 to 45 subscribers (with amplifier) according to the length of the line between the first and last subscriber. Calculations are based on the requirement that the signal strength available for the last subscriber shall be at least equal to the strength at the junction of the down-lead to the amplifier input terminals. It is assumed that the special screened and braided aerial lead type SSA 62 is employed : this has an attenuation of 0.8 neper/km at 200 kc/s and 2.2 neper/km at 1300 kc/s. For the very similar lead-covered aerial cable type SSA 63 the corresponding values are 0.7 and 1.7 ; its " coupling resistance " also is lower (and its screening action therefore better). The frequency band allowed for is 150–1500 kc/s. The aperiodic amplifier circuit is given in Fig. 11 ; Fig. 12 shows its amplification curve, the dip at 841 kc/s being due to the wave trap circuit *F* whose purpose is to prevent cross-talk arising from over-modulation by the local station.

3375. Antennas with Reduced Zenith Radiation [System of 4 Aerials of Height $\lambda/6$, $\pi/2$ Out of Phase, for Long-Wave Broadcast Band : System of 6 Aerials of Height $\lambda/2$, $2\pi/3$ Out of Phase, for Medium Broadcast Band : Calculated Characteristics].—M. Chireix. (*Bull. de la S.F.R.*, Nov./Dec. 1935, Vol. 9, No. 5, pp. 132–148 : in French and English. Also *L'Onde Élec.*, July, 1936, Vol. 15, No. 175, pp. 440–456 : French only.) The writer mentions the usefulness of such a system for long waves, in reducing the " Luxembourg Effect."

3376. A Free Metal Tower, carrying an Aerial, Loaded with Coils, as a Radiator for Waves in the Broadcast Telephony Range [Beromünster].—E. Metzler. (*Hochf: tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, pp. 154–155.)

This tower is now being used at Beromünster. It is shown in Fig. 1, with the measured current distribution along it. The tower proper carries a vertical aerial 35 m high, loaded with a tuning coil. Measurements of current distribution under various earthing and tuning conditions showed that the insulated tower is to be preferred.

3377. Aerials at Modern Broadcasting Stations [including the Northern Ireland Cantilever Mast with Capacity Ring and Adjustable Extension, and the WMAQ Uniform Mast with Inductance inserted in Gap at 80 ft from Top].—H. L. Kirke. (*World-Radio*, 19th June, 1936, Vol. 22, pp. 8–9.)

3378. The Diamond Aerial [as used at W6AM : Directional or Bi-Directional by Switching]. —D. C. Wallace. (*Television*, July, 1936, Vol. 9, No. 101, p. 414.)

3379. General Features of the Free-Standing Triangular Wooden Tower at W3ZD [Design suitable for Heights of 70 ft and over].—F. P. Cartwright. (*QST*, July, 1936, Vol. 20, No. 7, pp. 37–38.)

3380. A Simple Method of adjusting Top-Loaded and Sectionalised Antennas.—G. H. Brown. (*Broadcast News*, April, 1936, No. 19, pp. 14–15 and 28, 29.)

3381. The Input Impedance of the Short-Wave Antenna.—B. Zomakion. (*Scientific Technical Collected Works*, 1935, Electrotechnical Institute, Leningrad, pp. 11–19 : in Russian.) " A more precise analysis of the calculation formulae for the input impedance of a doublet antenna than the existing Russian ones " [Bontch-Bruevich, Tatarinov, etc.].

3382. Radiation from an Antenna over a Plane Earth of Arbitrary Characteristics [Derivation of Formula].—W. W. Hansen and J. G. Beckerley. (*Physics*, June, 1936, Vol. 7, No. 6, pp. 220–224 : *Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 889, abstract only.)

" A rigorous and easily computed formula for the total radiation from an arbitrary current distribution above a plane ' earth ' of arbitrary characteristics is developed. The fields may also be found, though they are not needed to compute the energy radiated. As a by-product, two new expansions in cylindrical co-ordinates of $\boldsymbol{i}(1)e^{ikr_{12}}/r_{12}$, where $\boldsymbol{i}(1)$ is a vector, are found."

3383. Earth Resistivity and Geological Structure : Discussion.—Card. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, pp. 836–837.) *See* 137 of January.

VALVES AND THERMIONICS

3384. High-Frequency [Micro-Wave] Properties of Triodes with an Anode of Large Diameter [Production of Oscillations of Continuously Variable Frequency].—E. Pierret. (*Comptes Rendus*, 6th July, 1936, Vol. 203, No. 1, pp. 50–52.)

Reasons are given for believing that micro-waves whose frequency is *continuously* variable may be obtained from triodes with a cylindrical anode of very large diameter by varying the anode voltage. The trajectories of the oscillating electrons will not reach the anode and may be varied continuously by changing the anode voltage. The anode current will remain zero and the oscillations will thus be difficult to detect ; resonance curves on Lecher wires will be very sharp. Such valves should be particularly useful for the measurement of dielectric constants. Valves have been constructed which verify these predictions and give a series of oscillation regions on wavelengths between 12 and 110 cm.

3385. A Straight-Filament Helical-Grid B-K Valve with Cylindrical Anode in Three Independent Sections.—Hershberger. (*See* 3330.)

3386. A Dimensional Relation in the Electron Motion in Alternating Electric Fields [Barkhausen-Kurz Oscillators, Electron-Multipliers, Cathode-Ray Tubes, etc.].—E. Brüche and A. Recknagel. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 17, 1936, pp. 241–242.)

"The mathematical treatment of transit-time phenomena has up to the present only been carried out for special cases. Without, however, an exhaustive theory it is possible to deduce from the equations of motion a 'dimensional law,' similar to that holding for static fields, which allows certain general deductions to be made. In static fields the following two similarity laws hold good :—(1) If we change similarly all the dimensions of the course of the ray (electrode lengths, etc.), then the electron paths will be increased in the same proportion ; and (2) the paths remain unaltered if all potentials (accelerating and deflecting potentials) are changed to the same extent ; since in the final formula for the action (*e.g.* of a deflecting condenser) there is always present only the ratio of two potentials.

"Now if, in addition, there is present a rapidly alternating electrical frequency ω, it follows from the equations of motion that a controlling factor for the course of the electrons is the quantity $\sqrt{e/m} . \sqrt{U'}/\omega l$, in whose numerator, in addition to constants, the electron velocity occurs, and in whose denominator another velocity—namely the dimensions of the apparatus divided by the time of oscillation—also occurs. This combination of values (which for simple cases, such as B-K oscillations and electron multipliers, can be more than a dimensional coupling since it gives, in itself, the important relation) indicates that the electron paths in two fields are similar when all dimensions and all potentials are similarly altered and when the above relation between these quantities and the frequency is fulfilled. Thus, for example, if a cathode-ray tube with a Hollmann deflecting condenser is to work at its best at a doubled frequency, then the electron velocity must also be doubled.

"Naturally, conclusions regarding the influence of magnetic fields, and of different values of e/m, on the course of the ray can be similarly drawn."

3387. An Investigation of the Magnetron Oscillator on the Basis of its Static Characteristics.—I. V. Brenev. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 6, 1936, pp. 677–685.)

Continuing the work referred to in 2612 of July, a general equation of the static characteristic curve of a split-anode magnetron is derived and a family of these curves calculated and plotted. On the basis of the curves so obtained, conditions are established for the self-excitation of a magnetron oscillator, and an analysis is made of the energy balance in the oscillating system. This is illustrated by a number of curves showing the effect of the operating constants on power input, power output, and efficiency of the system. It is stated in conclusion that the data obtained in the two papers are sufficient to enable the performance of a magnetron to be predicted for any set of operating conditions.

3388. Magnetron Generators [Diode and Split-Anode Types : Electronic, Dynatron and Rotating-Field Oscillations : a Survey].—A. Žáček. (*Slaboproudý Obzor*, Nos. 1 and 2, Vol. 1, 1936, pp. 6–9 and 22–26 : in Czech.)

3389. Excess Energy Electrons in High Vacuum Tubes [which pass to More Negative Electrode than Original Cathode and appear when Magnetic Field parallel to Filament exceeds Cut-Off Value].—E. G. Linder. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 860 : abstract only.)

3390. Modern Multi-Grid Valves [including the Octode : Noise due to "Induction Effect," serious at 10 m Wavelength : Grid Current to Negatively-Biased Grid, due to Transit-Time Effect : etc.].—M. J. O. Strutt. (*Bull. Assoc. suisse des Élec.*, No. 13, Vol. 27, 1936, pp. 369–370 : summary of address.)

3391. A New Electron Tube having Negative Resistance [Avoidance of Usual Necessity of Electrode at Higher Potential than Active Electrode, by Cylindrical "Venetian Blind" Grid : with Magnetic Field to render Critical the Effect of Anode Voltage on Secondary Grid Current].—J. Groszkowski. (*Proc. Inst. Rad. Eng.*, July, 1936, Vol. 24, No. 7, pp. 1041–1049.)

3392. Abnormal Frequency Combinations in a Frequency-Changing Valve [are essentially due to the Structure of Its Statical Characteristics].—M. Lambrey and S. Krauthamer. (*Comptes Rendus*, 6th July, 1936, Vol. 203, No. 1, pp. 48–50.)

3393. The Diode as Half-Wave, Full-Wave and Voltage-Doubling Rectifier : with Special Reference to the Voltage Output and Current Input [and Required Reservoir Capacity : Theory and Experimental Tests].—N. H. Roberts. (*Wireless Engineer*, July and August, 1936, Vol. 13, pp. 351–362 and 423–430.) "Recently in the course of the design of a cathode-ray-tube equipment, the author discovered the lack of practical data relating to the construction of a diode rectifier which is to supply a low current to a high resistance load." For Marique's work *see* 1391 of 1935.

3394. Electron Space Charge and the Theory of the Triode.—V. Lukoshkov. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 6, 1936, pp. 624–643: *Tech. Phys. of USSR*, No. 5, Vol. 3, 1936, pp. 408–432: in English.)

Author's summary:—On the basis of the most general conceptions of the properties of triodes by means of the so-called "constant-current curves" (Figs. 1 and 18) the author shows that the classical equation (1) for the current in a plane triode [Barkhausen-Langmuir equation] does not correspond to the facts when the anode potential is near to zero and when the grid potential has a large positive value. At the same time he shows that equation (1) was not rigidly derived. He then develops a new method for deriving the triode equation, taking into account both the effect of the space charge between cathode and grid and that between grid and anode. In this way he is led to the concept of an "ideal grid" with an infinitely small pitch and arbitrary shielding factor (Durchgriff).

He thus shows that an electronic discharge, during which the initial velocity of all electrons is equal and in general quite large, takes place between grid and anode. On working out a detailed theoretical analysis of this phenomenon and finding the largest limiting current flowing between grid and anode, he derives a general equation for the constant-current curves of a plane triode with an "ideal" grid. An analysis of these curves is made, some typical curves are constructed and some of the divergences between theoretical and experimental constant-current curves are explained. The breaks found in the theoretical constant-current curves are related to the discontinuous transfer of the electron-discharge condition between grid and anode (drop in current). The classical equation for the plane triode is also obtained, together with the limits of its applicability.

3395. The Effect of the Electron Current in a Triode on the Anode/Grid Capacity.—N. F. Alekseev. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 6, 1936, pp. 662–676.)

An account of experiments carried out with triodes having flat electrodes and indirectly heated cathodes. In these experiments the effect of the electron current on the anode/grid capacity was investigated for various anode and grid voltages on wavelengths between 5 and 19.6 m. The circuits and methods used are described in detail, and a number of curves are shown. The usual decrease in the inter-electrode capacity was observed, and also an increase in the damping of the circuit. It appears, however, that under certain conditions the inter-electrode capacity may also increase (up to 30%). A theoretical interpretation of the results obtained is given.

3396. On the Effect of Secondary Emission in Multiple-Electrode Tubes using Positive Resistance Characteristics.—H. Ando and T. Muraoka. (*Journ. I.E.E. Japan*, April, 1936, Vol. 56 [No. 4], No. 573, p. 337: Japanese only.)

3397. New Lines of Design in Valve Construction [the Harries "Critical Distance" Valve: the Electron-Beam Valve Type KDD1: the Schade 6L6].—R. Wigand. (*Funktech. Monatshefte*, June, 1936, No. 6, p. 210.)

3398. Circuit Considerations in the Use of Beam Power Tubes [Type 6L6].—W. N. Durham. (*Rad. Engineering*, June, 1936, Vol. 16, No. 6, pp. 20–21.)

3399. General Theory and Application of Dynamic Coupling in Power Tube Design [and the Development of the 6B5 Six-Prong Unit with Power-Section Input Impedance in series with Cathode/Ground Circuit of Driver Section: Advantages over other Valves].—C. F. Stromeyer. (*Proc. Inst. Rad. Eng.*, July, 1936, Vol. 24, No. 7, pp. 1007–1026.) The full paper, a summary of which was referred to in 3058 of 1935. A current-surge phenomenon caused by secondary emission, and its elimination in the commercial valve, is mentioned.

3400. A New American Output Valve, the 6B5 [with Cathode of First Triode System connected to Grid of Second].—De Quant and Metzelaar. (*Radio Centrum*, 30th April, 1936, Vol. 2, No. 18, pp. 244–245: in Dutch.)

3401. A Study of the Performance of the Triode Type UB-180 in the Last Stage of a Class A Amplifier [Power Output 12.5–16.5 Watts with Non-Linear Distortion not exceeding 5%].—L. Merelli. (*Scientific Technical Collected Works*, 1935, Electrotechnical Institute, Leningrad, pp. 3–10: in Russian.)

3402. The 300A Vacuum Tube [Advantages over 242A Triode for Sound-Picture and P. A. Systems: Less than Half Plate Potential, etc.].—J. O. McNally. (*Bell Lab. Record*, July, 1936, Vol. 14, No. 11, pp. 365–368.)

3403. New Receiving Tubes [Types 1F4, 1F6, 5W4, 6N7].—(*QST*, July, 1936, Vol. 20, No. 7, pp. 60 and 62.) 2-volt pentode power amplifier and duo-diode-pentode, and two metal types, a rectifier and a Class B twin amplifier.

3404. Power-Saving Tubes with Copper Cathodes.—(*Electronics*, June, 1936, Vol. 9, No. 6, p. 44.) *See* 1454 of April.

3405. On the Development of Broadcast Receiving Valves [and the Difficulties encountered at each Advance].—F. Bergtold. (*Funktech. Monatshefte*, June, 1936, No. 6, pp. 207–209.) For instance, the use of ceramic insulating discs, to stiffen the construction, leads to trouble due to bombardment of these parts and the necessity of screening measures.

3406. " RADIO RECEIVING AND TELEVISION TUBES " [including Vacuum Tubes for Distant Control of Industrial Processes and Precision Measurements : Book Review].—Moyer and Wostrel. (*P.O. Elec. Eng. Journ.*, July, 1936, Vol. 29, Part 2, p. 169.)

3407. THE CATHODE-RAY TUBE AS POTENTIAL MEASURER FOR THE ELECTROLYTIC TROUGH [for Study of Valves, etc.].—von Ardenne. (*See* 3553.)

3408. THE PREPARATION AND INVESTIGATION OF OXIDE CATHODES OF COLLOIDAL STRUCTURE [Deposition Time reduced by Glycerin or Glycol Methods : etc.].—Patai and Tomaschek. (*Kolloid-Zeitschr.*, April, 1936, Vol. 75, pp. 80–88.) For a previous paper *see* 2628 of July.

3409. INFLUENCE OF SLIPPING-PLANE TRACKS ON THERMIONIC EMISSION. II.—H. Mahl and D. Schenk. (*Zeitschr. f. Physik*, No. 1/2, Vol. 101, 1936, pp. 117–120.)

For I *see* 1805 of May. " Lines of different emission occur in the thermionic emission from surfaces of metal crystals covered with extraneous electro-positive atoms. These give the effect of a cross-hatching of the crystal surface and may be explained as tracks of slipping planes, in which the covering of extraneous atoms is denser than on the crystal surface itself." Electron-optical pictures showing this effect are given and discussed.

3410. CATHODE SPUTTERING IN ARC DISCHARGES.—L. R. Koller. (*Physics*, June, 1936, Vol. 7, No. 6, pp. 225–231.)

Measurement of " number of atoms of thorium sputtered from tungsten by positive ions of various velocities in the positive column of an arc discharge " ; threshold for mercury ions ; variation of number of sputtered atoms with filament temperature and arc current ; observations of rate of loss of barium from an oxide-coated cathode ; difference in nature between material evaporated and sputtered from oxide-coated cathode, etc.

3411. EQUATIONS OF STATE OF ONE- AND TWO-DIMENSIONAL GASES OF HARD ELASTIC SPHERICAL ATOMS OF FINITE SIZE [connected with Monatomic-Film Theory].—L. Tonks. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 878 : abstract only.)

3412. SOME PROPERTIES OF CAESIUM AND OXYGEN FILMS ON TUNGSTEN [Heats of Evaporation and Diffusion, etc.].—J. B. Taylor and I. Langmuir. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, pp. 878–879 : abstract only.)

3413. THE HEAT CONDUCTIVITY OF TUNGSTEN AND THE COOLING EFFECTS OF LEADS UPON FILAMENTS AT LOW TEMPERATURES [Theory and Equations : Calculated Low-Temperature *versus* Current Scale : Experimental Determination of Heat Conductivity].—I. Langmuir and J. B. Taylor. (*Phys. Review*, 1st July, 1936, Vol. 50, No. 1, pp. 68–87.) For previous work *see* 574 of February.

3414. SURFACE IONISATION OF BARIUM ON TUNGSTEN [Molecular Beam of Barium strikes Tungsten : Variation of Resulting Positive Ion Current with Temperature : Estimation of Ionisation Efficiency].—A. N. Guthrie. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 868 : abstract only.)

3415. A DETERMINATION AND ANALYSIS OF THE THERMIONIC CONSTANTS OF THORIATED TUNGSTEN.—A. Rose. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, pp. 838–847.)

" The temperature-dependent patch distribution is established as the most important determinant of the variation of the thermionic constants of thoriated tungsten with applied field and activation." Nine distinct observed facts are enumerated and " analysed in terms of an assumed patch distribution of adsorbed atoms such that the concentration difference between patches decreases with increasing temperature. More complete information is presented concerning the temperature coefficients of the work function for thoriated tungsten, and the precautions necessary before comparisons are made with temperature coefficients obtained photoelectrically or by contact potential measurements."

3416. THORIATED TUNGSTEN ACTIVATION AS REVEALED BY THE ELECTRON MICROSCOPE [Description of Heating Effects : Eruptions].—A. J. Ahearn and J. A. Becker. (*Phys. Review*, 1st June, 1936, Series 2, Vol 49, No. 11, p. 879 : abstract only.)

3417. THE PRODUCTION AND INVESTIGATION OF A NEW SOURCE OF ALKALI IONS [Outgassed Tungsten Powder with Alkali Chloride], *and* EXPERIMENTS ON PHENOMENA OCCURRING WITH THE IMPACT OF POSITIVE CAESIUM IONS ON AN OUTGASSED TUNGSTEN SURFACE [Reflection of Ions : Electron Emission : Change of Surface Properties : Saturation Effect with Monatomic Caesium Film].—J. Koch. (*Zeitschr. f. Physik*, No. 11/12, Vol. 100, 1936, pp. 669–684 : pp. 685–701.)

3418. ANOMALOUS SECONDARY ELECTRON EMISSION [from Oxidised Aluminium coated with Monomolecular Layer of Caesium Oxide].—L. Malter. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 879 : abstract only.) *See* 3419, below.

3419. THIN FILM FIELD EMISSION [from Electrolytic Films of Aluminium Oxide treated with Caesium and Oxygen].—L. Malter. (*Phys. Review*, 1st July, 1936, Series 2, Vol. 50, No. 1, pp. 48–58.) Extended report of work referred to in 2188 of June.

3420. THE TEMPERATURE DEPENDENCE OF FIELD CURRENT EMISSION [Measured with Geiger-Müller Counter].—R. T. K. Murray. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 878 : abstract only.)

3421. Secondary Electron Emission from a Hot Nickel Target due to Bombardment by Hydrogen Ions [Measurements].—Monica Healea and E. L. Chaffee. (*Phys. Review*, 15th June, 1936, Series 2, Vol. 49, No. 12, pp. 925–930.)

3422. Measurement of the Volta Effect [and Photoelectric Effect] with Pure Metals [by Method of Photoelectric Saturation Current : Correctness of Chemical Theory of Volta Effect : Photoelectric Effect in general Parallel to Volta Effect].—F. Krüger and G. Schulz. (*Ann. der Physik*, Series 5, No. 4, Vol. 26, 1936, pp. 308–330.)

3423. The Positive Ion Work Function of Molybdenum [Variation with Temperature measured by Mass Spectrograph].—H. J. Grover. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 878 : abstract only.)

3424. Contact Potential Differences between Surfaces of Single Crystals of Various Orientations. I [Measurements of Work Functions of Bismuth Crystal Surfaces from Current/Voltage Characteristics].—H. Kurzke and J. Rottgardt. (*Zeitschr. f. Physik*, No. 11/12, Vol. 100, 1936, pp. 718–725.)

3425. The Measurement of Contact Potential Difference [by New Magnetron Method enabling Contact Potential of Given Surface to be measured with respect to Hot Tungsten Filament : Conditions for Accuracy : Typical Results for Surfaces of Zinc and Molybdenum].—C. W. Oatley. (*Proc. Roy. Soc.*, Series A, 2nd June, 1936, Vol. 155, No. 885, pp. 218–234.)

3426. The Thermal Expansion Coefficient of Barium and Calcium and the Question of Allotropic Modifications [Barium thermally Unstable between 0° and 400°C, Coefficient depends on Thermal History].—P. G. Cath and O. L. von Steenis. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 17, 1936, pp. 239–241.)

3427. Some High-Temperature Properties of Niobium [Measurements of Electron Emission, Specific Resistance, Total Thermal Radiation, Rate of Evaporation of Metal as Function of Temperature, Melting Point].—A. L. Reimann and C. K. Grant. (*Phil. Mag.*, July, 1936, Series 7, Vol. 22, No. 145, pp. 34–48.)

DIRECTIONAL WIRELESS

3428. The Radiaura [Double-Modulation Ultra-Short-Wave System giving Multiplex Conversation between Any Number of Stations within Visual Range : also providing Visual Warning of Entrance of One or More Machines within Danger Zone around Aeroplane : etc.].—J. L. Hills. (*Aeroplane*, 10th June, 1936, Vol. 50, p. 743.) Short account of demonstration.

3429. Emission Arrangement for Production of Guiding Rays.—A. Gothe and L. Bestle : Telefunken. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, p. 176 : German Patent 624 052 of 18.11.1933.)

The rays are formed by alternate emission of two directed beams rotated through an angle relative to one another. They are produced by an aerial and two reflectors (Fig. 8). The tuning of the reflecting aerials affects the direction of maximum radiation.

3430. Method of Signal Emission for guiding Aeroplanes landing in Fog.—A. Leib : Telefunken. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, p. 176 : German Patent 622 615 of 27.7.1933.)

Two asymmetrical beams with different modulation frequencies are emitted from the same place. They are shown in Fig. 7 in three projections. The first beam gives the landing curve as the locus of equal field strengths. The second serves to indicate the correct side for landing and varies less with height than the first. The landing curve is the locus of intersection of surfaces of a given field strength for the two beams. The beams are picked up by the same receiver, which separates the modulation frequencies at the output and leads them to different indicators.

3431. Aircraft Landing Beam Transmitters protected from Over-running by Use of Reflectors [and Sunk Room].—Telefunken. (German Pat. 608 440 : *Funktech. Monatshefte*, June, 1936, No. 6, p. 238.)

3432. The Reduction of Night Error in Radiogoniometry by the Adcock Aerial System.—Busignies. (*Génie Civil*, 11th July, 1936, Vol. 109, p. 48 : summary of lecture.)

3433. Rain Static [particularly affecting Aircraft].—Morgan. (*See* 3303.)

ACOUSTICS AND AUDIO-FREQUENCIES

3434. Low-Frequency Retroaction in Valve Amplifiers [giving "Greatest Possible" Perfection of Amplification : Increased Sensitivity and Decreased Distortion].—M. Marinesco. (*L'Onde Élec.*, July, 1936, Vol. 15, No. 175, pp. 469–475.) *See* 1821 of May and back references ; *also* 615 of February. The present paper, however, actually deals only with non-linear distortion, the method of frequency-distortion compensation being merely referred to.

3435. An Experimental Study of the Non-Linear Distortion in Audio Amplifiers [particularly the Influence of the Load : Baggally's Circuit as an Intermediate Stage, and some Disadvantages].—A. Riskin and N. Besladnoff. (*Scientific Technical Collected Works*, 1935, Electrotechnical Institute, Leningrad, pp. 30–35 : in Russian.) For Baggally's method *see* 1934 Abstracts, p. 43.

3436. HIGH-FIDELITY AUDIO AT LOW COST: A SIMPLE AND INEXPENSIVE POWER AMPLIFIER UNIT OF STRIKING PERFORMANCE [using the "Kathodyne" Circuit and Two Type 6L6 "Beam" Valves for 14 Watts Output with 2% Total Harmonic Distortion].—A. G. Hull. (*QST*, July, 1936, Vol. 20, No. 7, pp. 34–36 and 90.) The "Kathodyne" circuit, as it is called in France, has attained great popularity in Australia. For severe criticism of it by Chrétien *see* 2996 of August.

3437. RECENT DEVELOPMENTS OF THE CLASS B AUDIO- AND RADIO-FREQUENCY AMPLIFIERS.—Barton. (*See* 3350.)

3438. TWO-WAY INTERNAL LOUDSPEAKER COMMUNICATION [Methods of avoiding Acoustic Retroaction between Loudspeaker and Microphone].—J. H. Reyner. (*Wireless World*, 24th July, 1936, Vol. 39, pp. 80–82.)

3439. THE VIBRATIONAL EQUATION OF A RIGIDLY FIXED PLATE [Inequalities satisfied by Frequencies of Natural Vibrations].—A. Weinstein. (*Comptes Rendus*, 8th June, 1936, Vol. 202, No. 23, pp. 1899–1901.)

3440. ON THE VIBRATION OF A HETEROGENEOUS CIRCULAR MEMBRANE [with Mass distributed according to an Inverse Square Law: Theoretical Solution: Equation for Overtone Frequencies: Comparison with Homogeneous Membrane].—F. E. Relton. (*Phil. Mag.*, July, 1936, Series 7, Vol. 22, No. 145, pp. 106–113.)

3441. THE INVERSE PIEZOELECTRIC PROPERTIES OF ROCHELLE SALT AT AUDIO-FREQUENCIES [Measurements of Inverse Piezoelectric Dilatation as Function of Temperature, Frequency, and Intensity of Applied Electric Field: Explanation in Terms of Theory of Relaxation Time].—O. Norgorden. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, pp. 820–828: abstract only p. 864.)

3442. THE INFLUENCE OF TEMPERATURE ON THE FREQUENCY OF PIEZOELECTRIC OSCILLATIONS IN ROCHELLE SALT.—Michailov. (*See* 3542.)

3443. ELECTRICAL CONDUCTIVITY OF CRYSTALS OF ROCHELLE SALT UNDER MECHANICAL FORCES [Increase of Conductivity: Cracked and Split Crystals have much Higher Conductivity than Perfect Ones].—F. Seidl with H. Prokesch. (*Zeitschr. f. Physik*, No. 3/4, Vol. 101, 1936, pp. 234–254.)

3444. PERMANENT MAGNET DRIVE FOR LARGE LOUDSPEAKER DIAPHRAGMS [Mobile Tubular Permanent Magnet with Ends inside Fixed Coaxial Coils].—Philips Company. (French Pat. 796 466, pub. 7.4.1936: *Rev. Gén. de l'Élec.*, 27th June, 1936, Vol. 39, No. 26, p. 207 D.)

3445. "AUTOMATIC TUNING" PRINCIPLE APPLIED TO FREQUENCY SWEEP FOR RECEIVER AND LOUDSPEAKER TESTING, ETC.—Hill. (*See* 3515.)

3446. AUTO-OSCILLATORY CIRCUITS GOVERNED BY FUNCTIONAL EQUATIONS [Loudspeaker/Microphone Combination, etc.].—Bovsheverov. (*See* 3329.)

3447. ON THE ACOUSTIC IMPEDANCE OF THE "AIR LAYER."—R. L. Volkov. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 6, 1936, pp. 700–708.)

The layer of air between a moving and a fixed body is often utilised in electro-acoustical apparatus, since it may provide either additional elasticity or additional damping. In the present paper the theoretical investigation of the properties of the air layer given by Crandall is further elaborated and certain correction factors are introduced.

3448. INVESTIGATIONS ON CARBON MICROPHONES [and the Periodic Resistance Variations occurring when a Constant Current passes through Microphones at Rest].—E. Waetzmann and G. Kretschmer. (*E.N.T.*, May, 1936, Vol. 13, No. 5, pp. 149–161.)

Previous work on these periodic resistance variations was referred to in 1930 Abstracts, p. 574 (Lohaus). The variations occurring in different types of microphones are shown in Fig. 2. With constant current, the voltage is a direct measure of the resistance, and the resistance variations were registered with a voltmeter (§ 2). The relative phases of resistance and temperature variations at different points inside the microphone were measured (§ 3, Fig. 3; for the technique used, *see* 3449, below). The phase of the temperature at the rim was found to be considerably behind that at the centre. The writers consider this fact to be of fundamental importance in the explanation of the resistance variations, given in § 4; the explanation is based on the expansion of the microphone membrane due to the heat produced by the current, and its subsequent flattening as the temperature of the rim rises and it expands. § 5 describes the suppression of the variations by keeping the rim at constant temperature, and the production of artificial resistance variations by varying the temperature at the rim. The relative phases of the resistance and the membrane expansion are shown in Fig. 7 (§ 6). These curves show that there are also irreversible resistance variations in the microphone (§ 7); the possible physical causes of this are discussed, in particular the relation of the carbon powder to the surrounding air. Carbon powder in other experimental arrangements also showed resistance variations (§ 8, Figs. 8, 9). The resistance of certain types of microphone also varies at constant voltage (§ 9).

3449. MEASUREMENTS OF TEMPERATURE IN CARBON MICROPHONES.—G. Kretschmer and A. Ueberschuss. (*E.N.T.*, May, 1936, Vol. 13, No. 5, pp. 162-163.)

See 3448, above. The instrument used to measure the temperature must not disturb the resistance variations and must have small inertia. A resistance wire in a capillary tube was chosen (Fig. 1). Its construction and use as the unknown arm in a bridge circuit are described and an example of the temperature/microphone-resistance curves obtained is given (Fig. 2).

3450. Spontaneous Resistance Fluctuations in Carbon Microphones and Other Granular Resistances [Measurements expressed by Formula], *and* Spontaneous Resistance Fluctuations and the Nature of a Microphonic Carbon Contact [Explanation of Experimental Results].—Pearson and Christensen. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 864 : 864–865 : abstracts only.) *See* 2674 of July, and Goucher, 1934 Abstracts, p. 327.

3451. Progress in Sound Pictures [Volume Range Expansion, Wider Frequency Range, Ultra-Violet Recording, etc.].—C. Dreher. (*Electronics*, June, 1936, Vol. 9, No. 6, pp. 6–10.)

3452. The "Mnémosyne" Automatic Repeating Gramophone [for learning "by heart": Rapid Selection of Paragraph required for Repetition, and other Special Features].—Pausert. (*Rev. Gén. de l'Élec.*, 18th July, 1936, Vol. 40, No. 3, pp. 89–93.) *See* also Routin, *Comptes Rendus*, 18th May, 1936, pp. 1661–1663.

3453. The Audio-Frequency Discriminator.—McLennan. (*See* 3369.)

3454. A New Sound-Level Meter [giving Measurements independent of Personal Element and at same time Results commensurate with Sensations experienced by the Ear].—A. J. Muchow. (*Gen. Elec. Review*, June, 1936, Vol. 39, No. 6, pp. 293–296.)

3455. Measurement of Acoustic Impedances by Comparison.—K. Schuster. (*E.N.T.*, May, 1936, Vol. 13, No. 5, pp. 164–176.)

This method of measurement of acoustic impedance is described as an acoustic analogy of a Wheatstone bridge. The unknown impedance is compared with a calibrated adjustable impedance. "The experimental arrangement consists of a system of two tubes (§ 1, Fig. 1); the 'principal tube' is closed at the sides by the two impedances to be compared; the sound-producing membrane is arranged at the middle in a position transverse to the tube. The 'auxiliary tube' connects the two parts of the principal tube; in the middle is the listening point, where a pressure node is formed when the bridge is balanced. The comparison impedance is a disc of felt of suitable thickness, behind which there is a hermetically sealed air column of variable length." This impedance is calibrated by a standing-wave method (§ 1a), of which the theory and calibration diagrams (Figs. 2, 3) are given. The determination of reflecting power and phase shift is considered theoretically (§ 1c); they are given by eqns. 7, 8, on which the impedance measurement method is based. The test for symmetry of the apparatus is described in § 1d; the degree of accuracy attained in the measurements and the frequency range are discussed in § 1e.

In § 2 measurements made with the apparatus are described; including the extension of the calibration to longer air columns, and measurements of the porosity of felt and other materials. The question of a calculable acoustic impedance is discussed in § 2c; the construction of impedance "standards" in the form of thick metal discs with a circular hole in the middle, to which is attached a tube of equal diameter and variable length, is found to give good practical results.

3456. Universal A.F. Oscillator for Measurements by the Compensation Method.—P. A. Matveev. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1936, pp. 43–52.)

In a.f. measurements by the compensation method it is necessary to provide two voltages of the same frequency but displaced in phase with regard to each other. The difficulty of using this method in practice is that the calibration of the phase variometer varies with frequency. In this paper a system is proposed in which this difficulty is obviated. The system makes use of two oscillators O_1 and O_2 oscillating respectively at frequencies $\omega + \Omega$ and ω, where ω is a high frequency and Ω the required audio frequency. The combined output from the two oscillators is fed to two detectors D_1 and D_2, but the output from O_2 is passed through a phase variometer before it is applied to D_2. The phase variometer thus always operates at the same frequency, and it is shown that the phase displacement of the a.f. output from D_2 is equal to that given to ω in the phase variometer. A full description is given of a model covering a range from 50 to 7000 cycles/second.

3457. The "Tone Meter," a Meter for Maximum Voltage with Logarithmic Scale [for Broadcast Programme Control, etc.].—H. G. Thilo and M. Bidlingmaier. (*E.N.T.*, May, 1936, Vol. 13, No. 5, pp. 176–183.)

This instrument is designed for use in the control of output in broadcast programmes, gramophone recording and sound film, in which the ratio of the smallest to the greatest amplitudes of sound is to be reduced to the value (*e.g.*) 1 : 100. It indicates the highest voltages reached and has a logarithmic scale; the construction principle is shown in Fig. 1 and the complete circuit in Fig. 2. The three parts of the circuit are (1) a valve voltmeter with a logarithmic scale for the amplified voltage, (2) a thermostat with signalling device to regulate the temperature of a copper-oxide rectifier used in (1), and (3) apparatus for connection to the mains. The design and construction of these parts are described. The instrument's range is 30–10 000 c/s.

3458. Electrical Correction of the Acoustics of a Studio [Use of Reverberation Chamber and Filters].—Établissements B. Roux. (French Pat. 796 075, pub. 28.3.1936 : *Rev. Gén. de l'Élec.*, 27th June, 1936, Vol. 39, No. 26, pp. 205–206 d.) *Cf.* 3069 of August.

3459. Resonance Absorption of Sound [Analysis of Dual Effect of System of Resonators in an Auditorium—"Additional Volume" or "Additional Absorption," according to Resonator Damping: Experimental Confirmation: Practical Significance of Resonance Absorption (*e.g.* for Compensating the Smaller Absorption at Low Frequencies): Possible More Effective Use of Sound-Absorbing Materials by inclusion in Resonators: etc.].—S. Rschevkin. (*Tech. Phys. of USSR*, No. 6, Vol. 3, 1936, pp. 560–576: in English.)

3460. "Elektroakustische Untersuchungen in Hallräumen" [Book Review].—H. Frei. (*E.T.Z.*, 16th July, 1936, Vol. 57, No. 29, p. 855.)

3461. The Fight against Noise: New Researches on Sound Isolating Materials.—(*Recherches et Inventions*, May/June, 1936, Vol. 17, No. 261, pp. 109–163.) Very full details of an investigation on commercial materials, carried out on the initiative of the Touring-Club de France.

3462. Filtration of Elastic Waves in Solid Rods with Membranes as Side Branches [Theory of Propagation of Compressional and Torsional Waves: Clamped Membranes form High-Pass Filters, Free Diaphragms give Low-Pass Filters].—R. B. Lindsay and T. G. Barnes. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 862: abstract only.)

3463. Differential Sensitivity in [Binaural] Sound Localisation, *and* On Auditory Intensity Discrimination.—M. Upton: Upton and Crozier. (*Proc. Nat. Acad. Sci.*, June, 1936, Vol. 22, No. 6, pp. 409–412: pp. 417–420.)

3464. Measuring Ear Sensitivity [Data of Tests on RCA Staff].—(*Broadcast News*, April, 1936, No. 19, p. 11.)

3465. The Ear as Sound Receiver [Comprehensive Survey].—A. Forstmann. (*Funktech. Monatshefte*, June, 1936, No. 6, pp. 215–222.) With over 40 literature references.

3466. "A Theory of Hearing as the Result of Microphone Effects in the Ear" [Theory including Electrical as well as Acoustic Effects in the Ear].—F. Leiri. (*Physik. Zeitschr.*, 1st July, 1936, Vol. 37, No. 13, p. 488: review of pamphlet.)

3467. The Audibility Threshold and Limit of Touch Sensation of Slow Sinusoidal Variations of Air Pressure.—G. von Békésy. (*Ann. der Physik*, Series 5, No. 6, Vol. 26, 1936, pp. 554–566.)

The range of frequencies studied is 1-50 c/s. For the method of determining the audibility threshold see 1830 of May. The threshold of excitation of the various sensations produced in the ear by sinusoidal pressure variations is shown in Fig. 1. These curves are discussed in detail; the sensation of intensity is not a continuous function of frequency (Fig. 2). The tickling sensations felt at high pressures are investigated in § 2 (scheme of apparatus, Fig. 3). § 3 deals with the loudness of pressure variations at the tickling threshold; there is a maximum apparent intensity of sound at low frequencies. Increase of audibility threshold by superposition of an audio-frequency tone is described in § 4; the audio-frequency tone appears to be modulated in intensity by the slow pressure variations.

3468. Recent Developments in Vibro-Tactile Research.—R. H. Gault. (*Journ. Franklin Inst.*, June, 1936, Vol. 221, No. 6, pp. 703–719.) For previous papers *see* 1934 Abstracts, p. 567 (two).

3469. Sensitivity of Insects to Sound [Frequency Response Curve quite Different from That of Normal Human Ear].—R. J. Pumphrey and A. F. Rawdon-Smith. (*Nature*, 13th June, 1936, Vol. 137, p. 990.)

3470. The Emission of Visible Light from Pure Liquids during Acoustic Excitation.—L. A. Chambers. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 881: abstract only.) *See* also 3086 of August.

3471. d'Alembert's Paradox at Supersonic Velocities [Resistance to Motion of Bodies moving through Fluids: Surrounding System of Waves and Velocities].—D. Riabouchinsky. (*Comptes Rendus*, 8th June, 1936, Vol. 202, No. 23, pp. 1887–1889.)

3472. The Production and Reception of Supersonic Waves, Modulated at Audio-Frequencies, by means of Piezo-Quartz Plates in Air and in Metallic Sound Conductors.—A. Kuntze. (*Ann. der Physik*, Series 5, No. 4, Vol. 26, 1936, pp. 349–371.)

The purpose of this work is the investigation of the application of piezo-quartz plates to the production of modulated supersonic waves, and of the nature of their mechanical oscillations. The scheme of the circuit used for production and reception of the waves and their modulation at audio-frequencies is given in Fig. 1; Fig. 2 shows the emitter circuit and Fig. 3 that of the receiving amplifier. The quartz plates used are described (§ IIb); a tube of given dimensions, lined with felt, was chosen as a vessel in which to do experiments at variable pressure, the reflections from its walls being negligibly small (§ IIc). Sources of interference from electric effects in the receiving circuit are discussed in § IId; the measurement of the acoustic wavelength and directional characteristic of the piezo-quartz are given in § IIe. The propagation and absorption of unmodulated supersonic waves in air of variable pressure is measured (§ III); there was no measurable variation of absorption with pressure. Modulated waves are dealt with in § IV. Resonance curves for various frequencies of modulation (the supersonic frequency being varied) and various pressures are shown in Fig. 6; there are three resonances in each case, corresponding to the supersonic carrier frequency and the two sideband frequencies. A modulation coefficient k is defined, calculated and measured in § IVb; it is the ratio of the amplitude of the modulating frequency to that of the carrier frequency and is shown to have the value given in eqn. 4. It is measured by a cathode-ray oscillograph at the output of the receiving amplifier and is found not to vary with pressure. Curves for k are also shown in Figs. 6, 7. The variations of k and of the logarithmic decrement δ with the ratio of modulating to carrier frequency (§ IVc, Figs. 8, 9) are also measured; anharmonic oscillations of the receiving quartz plate are demonstrated in § ivd with a theoretical and practical discussion (resonance curves Fig. 11). Experiments with metallic conductors of sound (cylindrical wires) are described in § v; the attenuation in the crystal was increased and the resonance curves showed no anharmonic effects. Values of the absorption coefficients in the metals are given.

3473. The Use of a Hot Wire to Locate the Nodes in a Stationary Sound Wave.—O. Tugman. (*Review Scient. Instr.*, July, 1936, Vol. 7, No. 7, pp. 287–288.)

The potential-difference change goes to zero at a point, locatable within 1 mm, on each side of nodal point; but the unexpected result was obtained that between these two zero-points, *i.e.* at or very near the node, the temperature of the wire increases.

3474. Dark Bands in the Spectra of Double Acoustic and Optical Diffraction Gratings [Description of Phenomena].—P. Cermak and H. Schoeneck. (*Ann. der Physik*, Series 5, No. 5, Vol. 26, 1936, pp. 465–473.)

PHOTOTELEGRAPHY AND TELEVISION

3475. Modulation of Light by an Oscillating Quartz Crystal.—H. E. R. Becker, W. Hanle and O. Maercks. (*Physik. Zeitschr.*, 1st June, 1936, Vol. 37, No. 11, pp. 414–415.)

The disadvantages of the Kerr cell for modulation of light are first discussed; the yield of light is not large, high voltages are required, the nitrobenzol used to fill the cell is not transparent in the violet and ultraviolet regions, and its double refraction becomes deleterious as the temperature increases. The writers therefore suggest the use of diffraction of light by supersonic waves instead of the Kerr cell [*cf.* 2726 of July] and have devised the arrangement shown in the figure. Standing supersonic waves are produced in the liquid F by the oscillating quartz crystal Q and reflector R. The supersonic lattice appears and disappears with a frequency equal to twice that of the crystal and thus modulates light passing through it. Advantages are that the yield of light is large, the method can be used in the ultraviolet region, the quartz only needs small voltages to excite the oscillation, and the energy used up in the liquid is very small, so that there is no noticeable rise in temperature. The arrangement can be used for l.f. modulation by exciting the quartz at a high frequency and modulating its amplitude. The highest frequency of modulation depends on the attenuation in the quartz crystal.

3476. The Possibilities of Light-Beam Television [with the Help of Electron Multipliers].—O. S. Puckle. (*Wireless World*, 31st July, 1936, Vol. 39, pp. 104–105.)

3477. We see Scophony Television: a Remarkable Advance.—(*Television*, July, 1936, Vol. 9, No. 101, pp. 391–393: *also* p. 397.)

3478. R.C.A. (America) Television Experiments [Demonstration at Camden].—R. C. A. (*Television*, July, 1936, Vol. 9, No. 101, p. 394.)

3479. The Kinnes Television System [Sound and Vision received on One Aerial and One Receiver, and requiring only One Wavelength (or Two, in latest Version) of Medium Frequency].—Kinnes. (*Television*, July, 1936, Vol. 9, No. 101, p. 400.)

3480. "The Best Presentation of Television yet made in France" [the Little Telecinema Transmitter of the Soc. Grammont, 240 Lines Interlaced, 2 Watts Output (0.2 Watts Sound): Disc Scanning].—(*L'Onde Élec.*, July, 1936, Vol. 15, No. 175, p. 409.) In the course of a discussion of the Paris Fair in May.

3481. Television: Recent Progress: the New Installation in Service in Paris.—R. Barthélémy. (*Ann. des Postes, T. et T.*, May, 1936, Vol. 25, No. 5, pp. 409–437.)

3482. The Synchronising Signal from the Eiffel Tower.—R. Barthélémy. (*Television*, July, 1936, Vol. 9, No. 101, pp. 401–402.) Based on the French paper dealt with in 2281 of June.

3483. Television Today—the *Status Quo* [Review of Progress since 1934: Remaining Problems: Purposes of R.C.A.–N.B.C. Tests.]—(*Electronics*, June, 1936, Vol. 9, No. 6, pp. 27–30 and 53, 54.)

Among other things, mention is made of a combination of Willemite, calcium tungstate and zinc borate, giving a brilliant white light: of an experimental "projection" tube embodying a "special material which becomes incandescent under the action of the electron current," giving an extremely brilliant picture which can readily be projected—the difficulty is the very short life of the incandescent material, but "large black-and-white pictures produced by this means seem to be coming": tubes with screen moulded separately, from high-quality glass, and then fused to funnel-shaped part of much inferior and cheaper quality: outline of tests from Empire State Buildings.

3484. Television in the United States [Technical Requirements].—J. Skinner. (*World-Radio*, 10th July, 1936, Vol. 22, p. 8.) Summary of paper at FCC conference in Washington.

3485. Television Progress in Germany.—(*Wireless World*, 10th July, 1936, Vol. 39, pp. 29–30.)

3486. Regular Television Service between Berlin and Leipzig.—(*Funktech. Monatshefte*, June, 1936, No. 6, Supp. p. 47.) For the inauguration of the trial service *see* 1873 of May.

3487. Television and Car-Ignition Interference.—(*Television*, July, 1936, Vol. 9, No. 101, p. 396.) Note on the combined S.A.E.-R.M.A. investigation referred to in 2985 of August.

3488. **The Comparative Performance of Gas-Focused and Electron-Lens-Focused Oscillographs at Very High Frequencies.**—L. S. Piggott. (*Journ. I.E.E.*, July, 1936, Vol. 79, No. 475, pp. 20–24: Discussion pp. 25–32, Plates between pp. 24 and 25.) The full paper, summaries of which were referred to in 1920 & 1921 of May and 2362 of June.

3489. **Fluorescent Screens for Cathode-Ray Tubes for Television and Other Purposes.**—L. Levy and D. W. West. (*Journ. I.E.E.*, July, 1936, Vol. 79, No. 475, pp. 11–19: Discussion pp. 25–32, Plate facing p. 24.) The full paper, summaries of which were referred to in 1870 of May and 2276 & 2362 of June.

3490. **Protecting Cathode-Ray Tubes.**—J. H. Reyner. (*Wireless World*, 17th July, 1936, Vol. 39, p. 71.)

3491. **The Potential of an Insulated Collecting Electrode in a High Vacuum** [*e.g.* the Screen in a Cathode-Ray Tube] **under Bombardment.**—H. Strübig. (*Physik. Zeitschr.*, 1st June, 1936, Vol. 37, No. 11, pp. 402–409.)

The question of the relative potential of a fluorescent metallic screen and the anode in a cathode-ray tube is connected with that of the mechanism by which charge is carried away from the screen; this may be a gas discharge in a gas-filled tube or secondary electrons in a hard tube. The underlying principles are here investigated with insulated metallic plates whose potential is measured with an electrometer (circuit and electrode arrangements Fig. 1). Fig. 2 shows an experimental charging curve for a nickel plate; the plate potential is practically equal to that of the anode up to a certain point, at which the curve bends over suddenly so that the plate potential remains approximately constant. This point is found to depend on the material under investigation, the previous treatment of the plate, and the angle at which the bombarding electrons strike it. To explain the phenomena, it is suggested that the final potential of the screen is that at which the secondary emission from it equals the number of electrons it collects. This suggestion is quantitatively confirmed by curves of secondary emission against voltage of the bombarding electrons (circuit Fig. 4, experimental curves Figs. 6–9). The effect of degassing in a vacuum and electron bombardment is also determined. The secondary emission is relatively large after degassing, decreases exponentially on bombardment and increases again on repeated degassing. The variation of secondary emission with the voltage difference between anode and screen (Fig. 10) is also considered theoretically and experimentally. The results with metallic screens are discussed in relation to fluorescent screens, which are considered to behave in a similar way; this would account for the cessation of increase in illumination intensity at definite voltages.

3492. **Electron Optical Systems and Their Applications.**—Zworykin. (*Journ. I.E.E.*, July, 1936, Vol. 79, No. 475, pp. 1–10.) Lecture before the Wireless Section: for synopsis *see* 3144 of August.

3493. **Electron Image Tubes: Focusing Properties.**—G. A. Morton and E. G. Ramberg. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 864: abstract only.)

An experimental and theoretical investigation of the variation of image distance and magnification with object distance, for systems of two cylinders of equal diameter, one of which is at cathode potential; also of the effect on both quantities of replacing the latter cylinder by a series of rings simulating a cylinder at linearly increasing or decreasing potential. "In both cases . . . the magnification is given . . . by one-half the ratio of image and object distance measured from the plane separating the two cylinders. Tables are shown giving the principal optical parameters of the systems" [not given in the abstract].

3494. **Electron Image Tubes: Aberrations** [Calculation and Measurement: Correction by Curved Cathode: Relation of Chromatic and Spherical Aberrations to Initial Electron Velocities].—E. G. Ramberg and G. A. Morton. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 864: abstract only.) *See* also above abstract (3493).

3495. **First Details of the Farnsworth Television Camera** [embodying the Multipactor].—Farnsworth. (*Television*, July, 1936, Vol. 9, No. 101, pp. 395–396.)

3496. **Secondary Electron Multipliers** [Preliminary Communication on German P.O. Researches since End of 1934].—G. Weiss. (*Funktech. Monatshefte*, June, 1936, No. 6, Supp. pp. 41–44.)

Preliminary tests to find the best source of secondary emission, on potassium, rubidium and caesium layers on oxidised silver, showed clearly that, as expected, caesium gave the largest emission: there was a maximum for a primary-electron velocity of about 600 volts (Fig. 1). For a constant preparation of the caesium deposit and a constant heating-out temperature (240° C) the oxidation of the pure silver surface was increased, by cathode discharge in oxygen, through the various stages recognisable by their colours: unlike the photo-effect, the secondary emission remained on the whole independent of the thickness of oxidation, though there was a fairly clear hump on the curve in the "dark blue" stage (Fig. 2), where an average multiplication of 10–11 was obtained. The heating-out temperature had a marked effect on the results. As this was raised, more and more caesium or caesium oxide evaporated off until, when probably a caesium surface layer only a few atoms thick was left, the photo-effect showed a maximum; although the secondary emission again showed less dependence on the caesium thickness (giving a multiplication above 3 from 180° to the practically complete expulsion of caesium at 375°) it had a clear maximum between 220° and 250°, approximately agreeing with the photo-effect maximum.

Tests with metals other than silver showed that the carrier metal had no direct influence but that its readiness to oxidise and the cleanness of its surface were important factors. Magnesium was the next best to silver; Zworykin includes zirconium and beryllium.

In the multipliers made by the writer (Figs. 5 and 6) with a series of fine-mesh gauze electrodes (10 000 meshes/cm^2) a 4 to 5 magnification per stage was obtained (Fig. 9). The optimum covering factor lay between 40 and 50%; with smaller values too many primary electrons passed through unmultiplied, with higher values the " penetration " of the succeeding grid was too small.. Fig. 7 shows the secondary emission as a function of meshes/cm^2 for a silver grid, the covering factor being kept approximately constant. It was found advantageous to make the collector electrode in the form of a wide-mesh grid followed by a few more close-mesh grids with decreasing potentials; this leads to a more effective use of the available voltage. Calculation of the optimum number of stages for a given total voltage is impeded by the lack of any known relation between V, the multiplying factor per stage, and the potential difference u between two stages: the writer shows how the optimum value of u can be obtained graphically from measurements on one stage. For anodes of grid form it proves to be about 60 volts: Zworkyin found 40–50 volts for plate anodes. Fig. 11 shows the over-all amplification as a function of over-all voltage for various numbers of stages.

Unlike ordinary hot-cathode valve amplifiers, the early stages of multipliers are no more susceptible to external disturbances, etc., than the final stages, as can be seen from equation 1. The determining factor for such susceptibility is the stage with the greatest steepness of characteristic, so that care should be taken to make all the stages similar. Fig. 12 shows a large-surface photocell with in-built multiplier. Such cells, with 100 to 500 multiplication, were used in the two-way television service referred to in 3968 of 1935. Later models, using a larger number of electrodes and with electron-optical concentration, give a multiplication of 10^6 and over.

3497. On the Experimental Results regarding Magnetic Electron-Multipliers of A.C. Type.—K. Okabe. (*Journ. I.E.E. Japan*, April, 1936, Vol. 56 [No. 4], No. 573, p. 339: Japanese only.)

3498. Anomalous Secondary Electron Emission [from Oxidised Aluminium coated with Monomolecular Layer of Caesium Oxide].—L. Malter. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 879: abstract only.)

3499. Time Lags in the Discharge of Gas-Filled Photocells in Darkness.—F. M. Penning. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 563–568: in German.)

Author's summary:—In certain gas-filled photocells the self-maintained discharge starts in absolute darkness only with a time lag, depending on the applied voltage. A very small illumination diminishes this time lag considerably. Below the starting potential a current due to thermionic emission of the cathode is flowing, the characteristic showing peculiar discontinuities. In connection with earlier experiments, these phenomena are explained by the influence of the cell window, acting as a third electrode with a large coefficient of secondary emission. When due attention is paid to the influence of a preceding discharge, the time lag diminishes as the temperature of the cell is increased.

3500. Photoelectric Emission from Alkali Deposits on Other Metals [Red Sensitivity is Result of Reaction between Alkali and Residual Impurity on Base Metal].—H. C. Rentschler and D. E. Henry. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, pp. 877–878: abstract only.) *See* also 1933 Abstracts, p. 169.

3501. The Distribution of Velocities of Photoelectrons in a Composite Caesium Cathode.—A. I. Pyatnitski and P. V. Timofeev. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 459–466.)

An account of experiments carried out with photocells using oxidised caesium and sulphur-caesium cathodes. Voltage/current curves of these cells are plotted, and by differentiation the corresponding velocity distribution curves are derived, in which the number of electrons is plotted against their velocity expressed in volts. The results so obtained are discussed and the following main conclusions reached:—(a) when the cell is illuminated by monochromatic light, the shape of the curve is determined by the wavelength of the light, and (b) on long waves the maximum is displaced towards electrons with higher velocities, while on short waves it is displaced towards electrons with lower velocities.

3502. Some Properties of Caesium and Oxygen Films on Tungsten [Heats of Evaporation and Diffusion, etc.].—J. B. Taylor and I. Langmuir. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, pp. 878–879: abstract only.)

3503. A Study of the First Spark Spectrum of Caesium as Excited by Electron Impact.—R. R. Sullivan. (*Phys. Review*, 15th June, 1936, Series 2, Vol. 49, No. 12, pp. 912–916.)

3504. A New Source of Alkali Ions, and Experiments on Impact of Caesium Ions on Outgassed Tungsten Surface.—Koch. (*See* 3417.)

3505. The Temperature Coefficient of the Photoelectric Work Function of Barium [Measurements].—R. J. Cashman and N. C. Jamison. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 877: abstract only.)

3506. The Energy Distribution of Photoelectrons from Sodium [Agreement between Theory and Experiment].—H. G. Hill and L. A. DuBridge. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 877: abstract only.)

3507. Use of the Image Potential for the Surface Photoelectric Effect [Calculations taking Account of Image Force between Electron and Metal].—R. D. Myers. (*Phys. Review*, 15th June, 1936, Series 2, Vol. 49, No. 12, pp. 938–939.)

3508. Variation of Resistance and Structure of Cobalt with Temperature and a Discussion of Its Photoelectric Emission. —L. Marick. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, pp. 831–837.)

3509. Measurement of the Volta Effect [and Photoelectric Effect] with Pure Metals.—Krüger and Schulz. (*See* 3422.)

3510. Contact Potential Differences between Surfaces of Single Crystals of Various Orientations.—Kurzke and Rottgardt. (*See* 3424.)

3511. "Les Phénomènes photoélectriques et leurs Applications" [Book Review].—G. A. Boutry. (*Génie Civil*, 27th June, 1936, Vol. 108, No. 26, p. 620.)

3512. An Investigation on the Action of X-Rays on Copper-Oxide Barrier-Layer Photocells *in Vacuo* [Vacuum decreases Sensitivity but completely eliminates Ageing Effect].—A. N. Kronhaus. (*Physik. Zeitschr. der Sowjetunion*, No. 5, Vol. 9, 1936, pp. 461–465 : in German.)

Preliminary attempts to prevent the decrease of sensitivity due to "ageing," by coating the cell with a transparent celluloid varnish, were unsuccessful, the ageing being only slightly delayed. The vacuum method, however, was quite successful, though the sensitivity was decreased (roughly to a half for both visible light and for X-Rays). On admission of air the sensitivity did not at once alter, but after two days it increased. It is mentioned at the end of the paper that when a cell coated with varnish was put in a vacuum its sensitivity did not alter either for light or for X-rays.

3513. On the Theory of the Photoelectromotive Force in Semi-Conductors.—L. Landau and E. Livshitz. (*Physik. Zeitschr. der Sowjetunion*, No. 5, Vol. 9, 1936, pp. 477–503 : in English.)

"The theories . . . published up to date cannot be regarded as satisfactory. Fröhlich [1529 of April] calculated the distribution function but made some erroneous assumptions. . . . . As to Frenkel's article [672 of February], it was obviously not intended to be serious. . . ." The writer deals first with the calculation of the e.m.f. in a semi-conductor with conduction electrons only. "All the cases observed experimentally up to the present are apparently not of the kind just discussed, but are such that the 'holes' [left in the places of their former states by the non-conducting electrons when they are thrown up, by the absorption of a light quantum, into the conducting zone] take part in the conductivity of the semi-conductor as well as the electrons." This case is then dealt with in section 5.

3514. The Photoelectric Effect of the Deuteron [Calculation of Cross-Sections for Deuteron Dissociation by Gamma Rays].—G. Breit and E. U. Condon. (*Phys. Review*, 15th June, 1936, Series 2, Vol. 49, No. 12, pp. 904–911.)

MEASUREMENTS AND STANDARDS

3515. Automatic Tuning : Some Applications of the Principle to Test Apparatus [Replacement of Motor-Driven Condenser (giving Frequency Sweep) by Combination of Frequency Change by Grid-Bias Variation and Thyratron/Condenser Circuit to give Bias varying with Time].—F. L. Hill. (*Wireless Engineer*, July, 1936, Vol. 13, No. 154, pp. 370–373.) For loudspeaker testing, receiver and filter resonance curves, alignment of receivers by c-r oscillograph, etc.

3516. Inductance Measurements using a Differential Transformer [Easier and More Precise Resistance Measurement by Addition of a Magnetising Winding with Reversing Switch : Application to Inductance Measurement].—W. A. Prowse. (*Journ. Scient. Instr.*, July, 1936, Vol. 13, No. 7, pp. 219–221.)

3517. A Combination Impedance-Wheatstone Bridge [Incorporation of Multipole Switch, Dry Cell and Rectifying Unit in Double Valve Voltmeter].—T. M. Hahn and B. Ragland. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 886 : abstract only.)

3518. Mutual Inductance.—Greig. (*See* 3315.)

3519. The Coefficient of Mutual Inductance between Two Turns of Wire wound on a Cylindrical Core of Magnetic Permeability μ.—N. N. Lebedev. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 530–536.)

A mathematical analysis is given of the magnetic field produced by a turn of wire wound on a cylindrical core of magnetic permeability μ. On the basis of the formulae so derived the coefficient of mutual inductance between two turns spaced a distance h apart is determined.

3520. On the Measurement of Very High Resistances [above about 5×10^{11} Ohms, by the "Accumulation" (Condenser Charge) Method : Technique eliminating the Effect of the Transient Current].—G. Vagliani. (*L'Elettrotec.*, 25th June, 1936, Vol. 23, No. 12, pp. 365–367.) *See* also Regogliosi, 1933 Abstracts, p. 633, r-h column.

3521. Supervision of High-Voltage Testing by Simultaneous Recording of Dielectric Loss.—G. Keinath. (*Elektrot. u. Masch:bau*, 21st and 28th June, 1936, Vol. 54, Nos. 25 and 26, pp. 289–292 and 304–310.)

3522. The Measurement of Discharges in Dielectrics [with Particular Reference to Cable Testing].—A. N. Arman and A. T. Starr. (*Journ. I.E.E.*, July, 1936, Vol. 79, No. 475, pp. 67–81 : Discussion pp. 88–94.)

3523. EXPERIMENTS ON THE NATURE OF THE POWER FACTORS OF CONDENSERS [and a Method of Measuring Dielectric Losses, independent of Phase Difference between Current and Voltage].—J. Lahousse. (*Rev. Gén. de l'Élec.*, 27th June, 1936, Vol. 39, No. 26, pp. 926–927.) Particularly valuable for large capacities of the order of 10 microfarads.

3524. MICRO-WAVE VALVES WITH CONTINUOUSLY VARIABLE FREQUENCIES FOR DIELECTRIC CONSTANT MEASUREMENTS, ETC.—Pierret. (*See* 3384.)

3525. THE MEASUREMENT OF DIELECTRIC CONSTANTS OF AQUEOUS SOLUTIONS OF ELECTROLYTES BY FÜRTH'S ELLIPSOID METHOD.—T. Lin. (*Ann. der Physik*, Series 5, No. 6, Vol. 26, 1936, pp. 495–512.)

The circuit used is given in Fig. 1; the h.f. generator used for wavelengths between 300 and 1200 m is shown in Fig. 2. The experimental process is described in detail and measurements on various electrolytes are given and discussed. The dielectric constants are found to be linear functions of the concentration; deviations from this law at small concentrations, found by previous workers, are found to be secondary effects due to the platinisation of the ellipsoid used.

3526. THE MEASUREMENT OF DIELECTRIC CONSTANTS AT ULTRA-HIGH FREQUENCIES [Parallel Wire Method: Change of Input Admittance: Application to Measurement of Reactances of Coils or Condensers].—R. King. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 865: abstract only.)

3527. THE ABSORPTION OF VARIOUS ALCOHOLS AT HIGH FREQUENCIES [No Absorption Bands for Wavelengths 3 to 12 m: Validity of Debye's Theory: Variation of Conductivity along Homologous Series of Alcohols].—R. Zouckermann and R. Freymann. (*Comptes Rendus*, 22nd June, 1936, Vol. 202, No. 25, pp. 2079–2081.)

3528. THE MEASUREMENT OF CONTACT POTENTIAL DIFFERENCE [by a Magnetron Method].—Oatley. (*See* 3425.)

3529. FREQUENCY MEASUREMENTS AT THE LABORATOIRE NATIONAL DE RADIOÉLECTRICITÉ [with Descriptions and Illustrations of the Equipment, including Wavemeters for Ultra-Short Waves].—B. Decaux. (*L'Onde Élec.*, July, 1936, Vol. 15, No. 175, pp. 411–439.)

3530. THE MAGNETOSTRICTIVE BAR AS A FOUR-POLE NETWORK.—V. I. Kovalenkov and N. A. Livschitz. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 445–450.)

A theoretical investigation of the oscillations of a bar subjected to the action of a magnetising force. The case of a bar with one end fixed and a sinusoidal force applied to the other end is examined first, and oscillation equations are derived similar to those used in the theory of passive networks. On the basis of the results obtained the general case is examined of a bar with one end fixed and sinusoidal forces continuously distributed along the axis. The equations obtained in this case are similar to those used in the theory of active networks. In both cases the forces of internal friction are taken into account.

3531. MECHANICAL, ELECTRICAL AND TIME PARAMETERS OF MAGNETOSTRICTIVE FILTERS.—Livschitz. (*See* 3317.)

3532. THE MAGNETOSTRICTIVE OSCILLATION OF QUARTZ PLATES [Frequency for Given Mode of Vibration the Same whether Crystal is excited by A.C. Field perpendicular to Electric Axis or by Vibrating Nickel Rod].—R. C. Colwell and L. R. Hill. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 888: abstract only.)

3533. CALCULATION OF THE COMPRESSIBILITY COEFFICIENTS OF CRYSTALS [with Identity of Nature of Elastic, Thermal and Raman Oscillations].—V. Ždanow. (*Zeitschr. f. Physik*, No. 1/2, Vol. 101, 1936, pp. 86–92.)

3534. THE EFFECT OF THE PARAMETERS OF A PIEZOELECTRIC QUARTZ OSCILLATOR ON ITS OPERATION, AND THE MAXIMUM PERMISSIBLE POWER RATING FOR SUCH AN OSCILLATOR.—V. A. Smirnov. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 493–513.)

The paper is divided into two main parts. In the first or theoretical part the operation of a piezoelectric quartz oscillator arranged in a normal Pierce circuit with a grid leak is discussed, and a new method is proposed for calculating the equivalent impedance of the crystal as determined by other parameters of the circuit. Methods are also indicated for estimating the relative amounts of the energy lost in the crystal through heat dissipation and oscillation of the surrounding air layer.

In the second part an account is given of experiments which were carried out with a view to investigating (a) the equivalent impedance of the crystal, (b) the effect of the parameters of the oscillator on its frequency and power output, and (c) the maximum permissible power dissipation in the crystal.

3535. OSCILLATING PLATES OF PIEZOELECTRIC QUARTZ WITHOUT VARIATION OF FREQUENCY WITH TEMPERATURE [for Long and Short Waves].—I. Koga. (*L'Onde Élec.*, July, 1936, Vol. 15, No. 175, pp. 457–468: to be continued.) Covering much the same ground as 1021 of 1935: *see* also 1382 & 2374 of 1935.

3536. CRYSTAL OSCILLATOR REQUIRING NO ADJUSTMENT.—H. Yoda. (*Journ. I.E.E. Japan*, March, 1936, Vol. 56 [No. 3], No. 572, p. 259: Japanese only, with diagrams.)

3537. PIEZOELECTRICITY OF QUARTZ IN LIQUID AIR [is not Zero].—H. Dobberstein. (*Naturwiss.*, 26th June, 1936, Vol. 24, No. 26, p. 414.) For work by Osterberg maintaining that quartz ceases to be piezoelectric at low temperatures, *see* 2768 of July: *see* also Bär, 2320 of 1935.

3538. New Sources for Piezo-Quartz Crystals [in Uganda].—(*Bull. Assoc. suisse des Élec.*, No. 14, Vol. 27, 1936, p. 406: paragraph only.)

3539. Proof of Variation of the Length of the Astronomical Day in 1935 by means of Quartz Clocks.—A. Scheibe and U. Adelsberger. (*Physik. Zeitschr.*, 1st June, 1936, Vol. 37, No. 11, p. 415.) *See* also 1893 of May and 3113 of August.

3540. "Recherches sur le Quartz piézoélectrique" [Book Review].—A. de Gramont. (*Rev. Gén. de l'Élec.*, 27th June, 1936, Vol. 39, No. 26, p. 914.)

3541. Two Types of Constant Frequency Oscillator.—Hayasi. (*See* 3336.)

3542. The Influence of Temperature on the Frequency of Piezoelectric Oscillations in Rochelle Salt [Abrupt Change in Temperature Coefficient on passing through Curie Point (23° C): Ratio of the T.Cs above and below: Cause of Change].—G. Michailov. (*Tech. Phys. of USSR*, No. 6, Vol. 3, 1936, pp. 511–517: in English.)

3543. Electrical Conductivity of Rochelle Salt under Mechanical Forces.—Seidl with Prokesch. (*See* 3443.)

3544. The Inverse Piezoelectric Properties of Rochelle Salt at Audio-Frequencies.—Norgorden. (*See* 3441.)

SUBSIDIARY APPARATUS AND MATERIALS

3545. The Weak Electrical Single Lens of Smallest Spherical Aberration.—Scherzer. (*Zeitschr. f. Physik*, No. 1/2, Vol. 101, 1936, pp. 23–26.)

An electrical lens is termed *short*, when the distance between the two principal points is small compared with the focal length; it is termed *weak*, when the potential inside the lens (measured along the optical axis) is subject only to small percentage changes. Here a theoretical investigation is given of the potential and electrode form of the short, weak single lens with the best spherical correction. It is deduced that the electron-optical system giving the best correction is not to be found among the short lenses.

3546. The Properties of the Immersion Objective in the Formation of [Electron-Optical] Images with Rapid Electrons.—Behne. (*Ann. der Physik*, Series 5, No. 4, Vol. 26, 1936, pp. 372–384.)

For previous work on immersion objectives *see* Johannson, 296 & 852 of 1935. Here the discussion, hitherto confined to the case when the velocity of the electrons leaving the source whose image they form is very small, is extended to the case when their velocity may have any value. The experimental arrangement of the cathode K, a piece of aluminium foil F with many small holes giving the electrons any desired velocity, and the immersion objective B_1B_2, is shown in Fig. 1. It was found that with constant anode voltage and increasing electron energy the ratio of voltages required on the immersion objective decreases (§ 3, Figs. 3, 4); the magnification increases with the electron energy (Fig. 6); the curves of grid (B_1) voltage as a function of electron voltage for various diameters of the object are parallel for constant anode (B_2) voltage (Fig. 5). The distribution of potential in the electric field is discussed (§ 4a) and the possibility of formation of images of disconnected objects is demonstrated, with examples (§ 4b, Figs. 8, 10). For results *see* 3547, below.

3547. Formation of Images of Foils with the Immersion Objective.—Behne. (*Ann. der Physik*, Series 5, No. 5, Vol. 26, 1936, pp. 385–397.)

For the experimental arrangement used *see* 3546, above. Here reproductions are given of electron-optical images, formed by (a) primary and (b) secondary electrons of various velocities, of various types of foils. Optimum voltage conditions for demonstration of foil structure are found. Optical images are compared with those formed by secondary electrons (Fig. 6), and the melting process of aluminium foil is studied (Fig. 8).

3548. A Dimensional Relation in the Electron Motion in Alternating Electric Fields.—Brüche and Recknagel. (*See* 3386.)

3549. The Potential of an Insulated Collecting Electrode in a High Vacuum under Electron Bombardment [*e.g.* Cathode-Ray Tube Screen].—Strübig. (*See* 3491.)

3550. Electron Optical Systems and Their Applications.—Zworykin. (*See* 3492.)

3551. The Comparative Performance of Gas-Focused and Electron-Lens-Focused Oscillographs at Very High Frequencies.—Piggott. (*See* 3488.)

3552. On the Method of Adjusting the Scale of Oscillogram in a Cathode-Ray Oscillograph.—Miyamoto. (*Journ. I.E.E. Japan*, March, 1936, Vol. 56 [No. 3], No. 572, pp. 205–206: English summary p. 18.)

3553. The Cathode-Ray Tube as Potential Measurer for the Electrolytic Trough [replacing the Usual Bridge/Telephone Combination: giving Photographic Record, and indicating Sense as well as Magnitude of Potential Deviation].—M. von Ardenne. (*E.T.Z.*, 16th July, 1936, Vol. 57, No. 29, pp. 831–833.)

By suitable arrangement of the fluorescent screen in relation to the trough electrodes, the physiological effect of the spot motion can be made to work-in accurately with the motion of the exploring electrode in the trough, controlled by the hand. The trough used in the writer's laboratory, with its pantograph movement, is illustrated, and some results on a simple accelerating lens are given as an example of the method.

3554. "Cathode-Ray Oscillography" [Book Review].—Macgregor-Morris and Henley. (*Distribution of Electricity*, July, 1936, Vol. 9, p. 2034.)

3555. FLUORESCENT SCREENS FOR CATHODE-RAY TUBES FOR TELEVISION AND OTHER PURPOSES.—Levy and West. (*See* 3489.)

3556. DISTRIBUTION FUNCTIONS OF PARTICLES ON A FLUORESCENT SCREEN.—Yu. V. Golbreich. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 451–458.)

A theoretical and experimental investigation of the distribution of particles in a dispersive medium used in the process of sedimentary deposition of a fluorescent material. The experiments were conducted with Zn_2SiO_4 and Zn_2SiO_4Mn dispersed in H_2O.

The distribution function with respect to mass (dM/dr) is assumed to be of the form $ar + br^2 + cr^3 + dr^4$, where r is the radius of the particle, and methods are indicated for determining the constants a, b, c and d. From this the distribution function with respect to the number of particles (dN/dr) is calculated, and also the surface integral. The distribution functions of the particles deposited during a time interval are next determined, and the distribution functions of the remaining particles in the dispersive medium are then found. Since the remainder of the suspensoid is wholly used in the production of the fluorescent screen, the last functions represent the distribution of the particles on the screen.

3557. PHOTO-REDUCTION OF FLUORESCENT SUBSTANCES BY FERROUS IONS.—Weiss. (*Nature*, 11th July, 1936, Vol. 138, pp. 80–81.)

3558. THE LIGHT ABSORPTION OF ADSORBED PARANITROPHENOL [at a Barium Fluoride Surface].—Custers and de Boer. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 407–417: in German.)

3559. REMANENT PHOSPHORESCENCE DUE TO X-RAYS.—S. D. Gerzriken and Z. D. Petrenko. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 6, 1936, pp. 753–754.) A preliminary communication on experiments with NaCl, calcite and fluorine which have shown that after having been X-rayed these substances become phosphorescent and retain this property in some cases for several weeks.

3560. OTHER PAPERS ON CATHODE-RAY AND ELECTRON-IMAGE TUBES. — (*See* under "Phototelegraphy & Television.")

3561. LOOP OSCILLOGRAPHS WITH HIGH RECORDING SPEED [Types for Film Speeds up to 15 and 50 Metres/Second: Times of a Few Milliseconds].—Blasczyk. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 17, 1936, pp. 242–243.) Suitable, among other things, for piezoelectric gas-pressure measurements, vibration recording, etc.

3562. TWO METHODS OF MAPPING FLUX LINES: DISCUSSION.—Godsey. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, p. 826.) *See* 320 of January.

3563. HIGH-VOLTAGE MERCURY-POOL TUBE RECTIFIERS [Ignitron Type: Application as High-Power Rectifiers for Radio Transmitters].—Foos and Lattemann. (*Proc. Inst. Rad. Eng.*, July, 1936, Vol. 24, No. 7, pp. 977–984.)

"Five amperes at sixteen kilovolts, however, represents about the best we could get out of these particular tubes with a fair degree of reliability. Application of this type of rectifier must, therefore, await the development of high-voltage ignitrons especially designed for this class of service. The possibilities are so attractive, however, that this development will undoubtedly be undertaken . . ."

3564. A COLD-CATHODE GRID-CONTROLLED ARC-DISCHARGE TUBE [Discharge of Several Hundred Amperes controlled by Very Small Amount of Grid-Circuit Power: as Stroboscopic Light Source: for Relay and Counter Circuits: as Saw-Tooth Oscillator for Sweep Voltages: etc.].—Germeshausen and Edgerton. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, pp. 790–794 and 809.) The emission is from a cathode spot on metal with a caesium coating.

3565. GRID-CONTROLLED RECTIFIERS: THE GRID-VOLTAGE/GRID-CURRENT CHARACTERISTIC WHEN ANODE CURRENT IS FLOWING.—Donaldson. (*Electrician*, 19th June, 1936, Vol. 116, pp. 811–812.) Illustrated by a curve plotted with the G.T.I. gas-filled relay.

3566. THE SERIES "ONDULEUR" [D.C./A.C. Converter using Two Grid-Controlled Ionic Tubes, in Series with Inductive Potential Divider, across Two Condensers in Series: Theory and Experimental Confirmation].—Gillon. (*Rev. Gén. de l'Élec.*, 27th June, 1936, Vol. 39, No. 26, pp. 915–926.) *See* also Schilling, 2401 of 1935. The same method of treatment can be applied to the parallel converter.

3567. CHANGING DIRECT CURRENT TO ALTERNATING CURRENT BY MEANS OF THYRATRONS [and Phanotrons].—Hull. (*Proc. Nat. Acad. Sci.*, June, 1936, Vol. 22, No. 6, pp. 389–393.)

3568. A SECOND SHEATH NEAR THE CATHODE OF AN ARC DISCHARGE [with Oxide-Coated Cathodes in Argon].—Warmoltz. (*Nature*, 4th July, 1936, Vol. 138, p. 36.)

3569. METHOD OF MEASURING THE ARC VOLTAGES IN RECTIFIERS UNDER WORKING CONDITIONS.—Wellauer and Stettler. (*Bull. Assoc. suisse des Élec.*, No. 15, Vol. 27, pp. 424–428: in German.)

3570. THE DIODE AS HALF-WAVE, FULL-WAVE AND VOLTAGE-DOUBLING RECTIFIER.—Roberts. (*See* 3393.)

3571. On the Question of the Oxidation of Copper at High Temperatures [Cu_2O stable below 375° C: Oxidation always begins by Formation of Thin Coat of CuO, below which the Cu_2O Layer then forms].—Arkharow and Worochilova. (*Tech. Phys. of USSR*, No. 5, Vol. 3, 1936, p. 492: summary only, in French.)

3572. Thermovoltage of the Element Metal/Semiconductor/Metal. I—Investigations on Various Specimens of Cuprous Oxide.—Mönch. (*Ann. der Physik*, Series 5, No. 6, Vol. 26, 1936, pp. 481–494.)

Measurements of temperature-variation of conductivity and thermovoltage of various polycrystalline Cu_2O-plates; summary of theoretical predictions; distinction between surface and volume portions of thermovoltage; comparison of experimental results with theory—in some specimens the surface and in some the volume portion of thermovoltage is dominant.

3573. Influence of Atmospheric Gases on the Electrical Conductivity of Cuprous Oxide [Qualitative Description].—Dubar. (*Comptes Rendus*, 6th July, 1936, Vol. 203, No. 1, pp. 46–48.)

3574. On a Property of Materials of High Electrical Resistance [Grid Leaks, etc., tested over Wide Potential Range: Heating kept Low by Rapid Sweep of Potential: Deviation from Ohm's Law].—Fukuda and Saito. (*Journ. I.E.E. Japan*, March, 1936, Vol. 56 [No. 3], No. 572, pp. 207–210: short English summary p. 19.) The method of increasing the applied potential quickly, using the transient phenomena of temperature-rise in the filament of a small kenotron, allowed the relation between the applied potential and the resistance of the sample to be measured instantaneously by an oscillograph.

3575. The Effect of Atmospheric Humidity on Unsealed Resistors: Causes and Remedy.—Dike. (*Review Scient. Instr.*, July, 1936, Vol. 7, No. 7, pp. 278–287.)

3576. Experiments on the Construction of Thin Electrolytic Oxide Films [support the Assumption that They are Porous].—Rummel. (*Zeitschr. f. Physik*, No. 9/10, Vol. 100, 1936, pp. 665–666.)

3577. Breakdown Voltage of Electrolytic Barrier Layers [Variation of Maximum Voltage with Dilution is Logarithmic: Breakdown Voltage independent of Thickness of Layer previously formed in Very Dilute Electrolyte].—Güntherschulze and Betz. (*Zeitschr. f. Physik*, No. 9/10, Vol. 100, 1936, pp. 539–542.)

3578. On the Dielectric Breakdown of Crystals [Single-Crystal Plates of Rock Salt and Fluorite: Directions of Breakdown referred to Space Lattice: Influence of Polarity of Inhomogeneous Field].—Saito. (*Journ. I.E.E. Japan*, March, 1936, Vol. 56 [No. 3], No. 572, pp. 211–216: short English summary p. 19.)

3579. An Investigation of the Amorphous State. VI [Temperature/Frequency Relations of Dielectric Losses and Dielectric Constants of Sugar and Glucose: in connection with Unexplained Losses in Certain Amorphous Substances (Silica & Boron Glasses, etc.): "Structural" Losses due to Relaxation Displacements of Molecules or Radicals, related to Density of Molecular Packing].—Alexandrov, Kobeko and Kuvshinski. (*Tech. Phys. of USSR*, No. 6, Vol. 3, 1936, pp. 495–507: in English.)

3580. The Breakdown and Flash-Over of Solid Dielectrics in Compressed Nitrogen.—Goldmann and Wul. (*Tech. Phys. of USSR*, No. 6, Vol. 3, 1936, pp. 519–527: in English.)

"The measurements with a.c. showed that surrounding a porous dielectric with compressed gas is not an effective means, compared with impregnation, of raising the electric strength of the solid dielectric. This is probably due to the large differences between the dielectric constants of solid and gaseous dielectrics." It was also found that the flash-over potential increased with the gas pressure and that this increase was the more rapid, the more homogeneous the electric field.

3581. Effect of Total Voltage on Breakdown in Vacuum: Discussion.—Anderson. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, pp. 830–831.) *See* 782 of February.

3582. Experiments on the Nature of the Power Factors of Condensers.—Lahousse. (*See* 3523.)

3583. Oil Condenser Characteristics [Remarks and Data on Condensers using Oil-Impregnated Paper].—(*Rad. Engineering*, June, 1936, Vol. 16, No. 6, pp. 16 and 19.) "Set manufacturers are showing interest in oil dielectric condensers."

3584. Improvement of the Electrical Characteristic of Kraft Paper by Electrodialysis.—Horioka, Kikuchi and Hiruma. (*Journ. I.E.E. Japan*, March, 1936, Vol. 56 [No. 3], No. 572 p. 260: Japanese only.)

3585. Improving the Heat Conducting Power of Insulating Materials.—Kvitner and Mnookhin. (*Elektritchestvo*, No. 10, 1936, pp. 35–39: in Russian.) For Meissner's work on the same subject *see* 3688 of 1935.

3586. The Testing, for Mechanical Properties, of Samples taken from Finished Parts [and the Design and Use of the "Dynstat" Apparatus.]—Nitsche. (*Zeitschr. V.D.I.*, 13th June, 1936, Vol. 80, No. 24, pp. 755–757.)

3587. Paramagnetic Relaxation [at 10–21 Mc/s: Experiments on Paramagnetic Substances in H.F. Magnetic Field, to compare with Behaviour of Dielectrics in H.F. Electric Field].—Gorter. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 503–514: in English.) For a preliminary communication *see* 1612 of April.

3588. Action of an Alternating Magnetic Field on Discs made of Magnet Steel [Rotation due to Hysteretic Forces at 50 c/s, and to Foucault Currents and Hysteretic Forces at 500 c/s].—Snoek. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 361–370 : in English.)

3589. Variation of Rigidity and of the Decrement of Torsional Vibrations with Magnetisation in Iron [Data].—Brown. (*Phys. Review*, 1st June, Series 2, Vol. 49, No. 11, p. 863 : abstract only.)

3590. Some Observations on the Movement and Demagnetisation of Ferromagnetic Particles in Alternating Magnetic Fields [Movement may be due to Reorientation : Stability of Demagnetisation produced by *Damped* H.F. Alternating Fields].—Davis. (*Physics*, June, 1936, Vol. 7, No. 6, p. 236.) *See* also 1975 of May.

3591. The Technique of Heat Treatments of Iron applied in the Communication Industry [with Results for " Armco," Swedish Iron, " Anhyster D " and Extra-Soft " D.S. Steel "].—Kostomaroff. (*Rev. Gén. de l'Élec.*, 4th July, 1936, Vol. 40, No. 1, pp. 17–24.)

3592. Magnetic and Electrical Properties of the Binary Systems MO. Fe_2O_3.—Snoek. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 463–483 : in English.)

Here M stands for iron, manganese, copper, nickel or magnesium. " The question whether the electrons, which are responsible for the conduction, have anything to do with the ferromagnetic character of some substances has caused considerable discussion. From the facts gathered above it seems safe to conclude that it is possible to produce a *single homogeneous* phase which is ferromagnetic and at the same time practically an insulator."

3593. The Ferromagnetism of Nickel. II—Temperature Effects [Calculations using Fermi Statistics].—Slater. (*Phys. Review*, 15th June, 1936, Series 2, Vol. 49, No. 12, pp. 931–937.) For I see 2826 of July.

3594. Analysis of Broadening of X-Ray Reflections by Strain [Theory giving Distribution of Lattice Spacings in Strained Material, *e.g.* Permalloy].—S. O. Rice. (*Phys. Review*, 1st June, 1935, Series 2, Vol. 49, No. 11, p. 862 : abstract only.)

3595. Energy and Lattice Spacing in Strained Solids [Theory of Cold-Worked Crystals, *e.g.* Permalloy].—Stibitz. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, pp. 862–863 : abstract only.)

3596. Energy of Lattice Distortion in Hard-Worked Permalloy [Measured by Broadening of X-Ray Reflection].—Haworth. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 863 : abstract only.)

3597. Effect of Annealing on the Properties of Hard-Worked Permalloy [Experimental Results interpreted in Terms of Energy of Crystal Lattice.].—Dillinger. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 863 : abstract only.)

3598. The Variation of Young's Modulus with Magnetisation in Permalloy [Data].—Siegel and Rosin. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 863 : abstract only.)

3599. Particle Size and Magnetic Susceptibility [No Effect for Copper or Lead].—Raj Verma and Anwar-ul-Haq. (*Current Science*, Bangalore, June, 1936, Vol. 4, No. 12, p. 869.) " Similar results are to be expected in the case of the rest of the elements provided no change is brought about in the crystalline structure during powdering or colloidalisation." The size-dependency found by Rao is attributed to carbon inclusions.

3600. The Effect of Crystal Structure on Diamagnetic Susceptibility.—Mathur and Nevgi. (*Zeitschr. f. Physik*, No. 9/10, Vol. 100, 1936, pp. 615–620.)

3601. A New Analysis of B-H Curves and Its Application to Ferromagnetic Behaviour : Part II.—Macmillan. (*Gen. Elec. Review*, June, 1936, Vol. 39, No. 6, pp. 284–292.)

3602. A Method of Magnetic Testing for Sheet Material [avoiding Inconvenience of Ring Sample].—Burgwin. (*Review Scient. Instr.*, July, 1936, Vol. 7, No. 7, pp. 272–277.)

3603. Theoretical Determination of the Intensity of the Magnetic Field produced by a Multi-Pole Electromagnetic System.—A. Ya. Sochnev. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 6, 1936, pp. 483–492.)

Electro-magnets of alternate polarity and mounted on either a flat or cylindrical surface are used in mining engineering for separating different kinds of ore. The author proposed some years ago the following experimental formula for determining the intensity of the field produced by such systems : $H = H_0 e^{-\alpha h}$, where H_0 is the field intensity at the pole ends, h the distance from the pole ends, and α a constant. In the present paper a detailed theoretical discussion is given to prove the validity of this formula. As a result of this discussion a number of other factors relating to multi-pole systems are also determined, such as the magnitude of the total magnetic flux and the conditions for a maximum force to be exerted on a grain at a given distance from the pole ends.

3604. Some Notes on the Design of an Impedance-Matching Transformer [*e.g.* Tapped Transformer for Variable Impedance Output Meter over Wide Frequency Range : Eddy-Current and Hysteresis Losses : the Auto-Transformer Circuit : Data on " Laminic " Iron].—R. M. Huey. (*A.W.A. Tech. Review*, April, 1936, Vol. 2, No. 2, pp. 65–74.)

3605. THE DETERMINATION OF THE COPPER LOSSES IN BROADCASTING COILS. — A. Weis. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, pp. 148–152.)

The losses in coils carrying an alternating current may be classified as due to (1) ohmic resistance, (2) eddy-current resistance arising from the natural field of the current in the coil, and (3) eddy-current resistance arising from the fact that the wires are wound up into a coil. Formulae for these are derived in § I; their relative magnitudes are illustrated by a numerical example (§ II). It is found that the loss from (2) is practically negligible for the "litzendraht" generally used. Fig. 4 gives a set of curves for use in calculating (3). The influence of the shape of the core on (3) is discussed in § III; eqn. 22 is a relation for determining the optimum effective length of coil for the smallest copper losses.

3606. A SENSITIVE POTENTIAL DIVIDER FOR LARGE CURRENTS [10 Amperes: Resistance Ribbon wound from One Roller to Another.]—Mason and Gray. (*Review Scient. Instr.*, July, 1936, Vol. 7, No. 7, pp. 289–290.)

3607. ALTERNATING-CURRENT VOLTAGE STABILISER [for Rectified D.C. Voltage Stabilisation: Process applied before Transformation and Rectification in preference to Usual Method: Two-Triode Circuit with Bias provided by Rectifier Units connected to Same Mains].—Rocha and Gross. (*Review Scient. Instr.*, July, 1936, Vol. 7, No. 7, p. 290.)

3608. A NEW VOLTAGE REGULATOR CIRCUIT [Operation of Control Grid of Valve at Positive Potential: Transients Eliminated: Large Current through Load Resistor in Anode Circuit].—Ashworth and Mouzon. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 886: abstract only.)

3609. IONIC GENERATOR GIVING A MILLION VOLTS [Construction of: Currents and Potentials attained].—Pauthenier and Moreau-Hanot. (*Comptes Rendus*, 8th June, 1936, Vol. 202, No. 23, pp. 1915–1916.) For principle *see* 1238 of March.

3610. THE ROCHESTER CYCLOTRON [Magnetic Resonance Accelerator: Data of Improved Design].—DuBridge and Barnes. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 865: abstract only.)

3611. MODIFIED DESIGN OF THE LINEAR ACCELERATOR FOR HIGH INTENSITIES [Theoretical Analysis indicates Modification for Production of Nearly Homogeneous, Very Intense Ion Beam].—Smith and Hartman. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 866: abstract only.)

3612. SIX MILLION VOLT MAGNETIC RESONANCE ACCELERATOR WITH EMERGENT BEAM.—Cooksey and Lawrence. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 866: abstract only.)

3613. NEW HIGH-VOLTAGE SYSTEM [Whirling Disc carrying Insulating Plates charged by Ionised Air from Corona Discharge].—Dahl. (*Science*, 26th June, 1936, Vol. 83, Supp. pp. 6–7.)

3614. THE DIRECT-CURRENT TRANSFORMER [and Some Recent Commercial Types using the Condenser-Bank "Parallel-Charge Series-Discharge" Principle]. — E. Schwandt. (*Funktech. Monatshefte*, June, 1936, No. 6, pp. 211–214.) *See* also Noack, 1934 Abstracts, p. 571.

3615. A METHOD OF DESIGN OF A POLARISED RELAY [Theory and Application]. — Ostroumov. (*Scientific Technical Collected Works*, 1935, Electrotechnical Institute, Leningrad, pp. 60–70: in Russian.)

3616. THE PHYSICS OF THE SLIP CONTACT. III. COMMUTATION OF CURRENT.—Schröter. (*Arch. f. Elektrot.*, 13th May, 1936, Vol. 36, No. 5, pp. 338–346.)

3617. A CONTINUOUS-VOLTAGE AMPLIFIER.—Monnier and Bazin. (*Comptes Rendus*, 22nd June, 1936, Vol. 202, No. 25, pp. 2052–2054.)

In a resistance amplifier the grids are at potentials very near that of the cathodes, while the anodes are at much higher potentials; it is impossible to connect the anode of the first valve directly to the grid of the second, if the latter is at approximately the same potential as the first grid. The circuit here shown and described is designed to overcome this difficulty. It consists essentially of a balanced bridge, of which two opposite corners are connected respectively to the cathode and to the output (anode) of a valve; one diagonal of the bridge is the filament/anode space. The amplification obtained is rather less than that given by the usual method; suggestions are made as to the relative dimensions of circuit elements to reduce the diminution as much as possible. The arrangement is said to permit of (1) feeding any number of stages with the same batteries, (2) uniting two batteries into one with tapping points for the cathodes, and (3) direct connection of the output of any stage whatever to the apparatus being used (electrometer or cathode-ray oscillograph).

3618. A PROPORTIONAL AMPLIFIER ON THE POTENTIOMETER PRINCIPLE.—Madsen. (*Zeitschr. f. Physik*, No. 1/2, Vol. 101, 1936, pp. 68–71.)

The circuit here described and shown in Fig. 2 is designed to give uniform amplification of amplitude and phase displacement over a wide frequency range. Pure ohmic resistances are used as coupling elements between the valves, and there is a common voltage source. The principle of the arrangement is elucidated with the help of equivalent circuits (Figs. 1a, b). The amplification may be still more increased by means of the retroaction produced by inserting a resistance in the common anode lead to the first and third valves.

3619. A CABLE CODE TRANSLATOR SYSTEM [Discussion].—Connery. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, p. 819.) *See* 1273 of March.

3620. A Guarding Cable sensitive to Temperature Rise [for Fire Alarm].—(*E.T.Z.*, 16th July, 1936, Vol. 57, No. 29, pp. 840–841.) As used on the s.s. "Président Doumer."

3621. A High-Speed Geiger-Counter Circuit [using Lower Resistances than Usual Circuit].—Neher and Harper. (*Phys. Review*, 15th June, 1936, Series 2, Vol. 49, No. 12, pp. 940–943.)

3622. A New Method of Registering Counter Coincidences; Discussion and Measurement of the Corrections to be applied to Coincidence Counts.—Ehmert and Trost. (*Zeitschr. f. Physik*, No. 9/10, Vol. 100, 1936, pp. 553–568.)

3623. Statistical Analysis of Counter Data.—Schiff. (*See* 3658.)

3624. A Direct-Reading Vacuum-Tube Speedometer for Random Counting.—Gingrich and Evans. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 886: abstract only.)

3625. Cold Temperature Luminescence? Remark on the Paper by A. Güntherschulze and H. Betz [on the Pale Luminescence from Oxide Layers during Oxidation].—Rummel: Güntherschulze and Betz. (*Zeitschr. f. Physik*, No. 3/4, Vol. 101, 1936, pp. 276–278.) For papers with which this discussion is concerned *see* 1932 Abstracts, p. 419: *also* 2807 of July and 3212 of 1935.

STATIONS, DESIGN AND OPERATION

3626. The Guernsey-Chaldon [Dorset] Ultra-Short-Wave Radio-Telephone Circuit [85-Mile Path, 1.73 Times the Optical Range: 5, 5½ and 8, 8½ Metre Channels: Superheterodyne Receivers with Automatic Gain Control: Crystal Stabilisation at Transmitters and Receivers.]—Mumford. (*P.O. Elec. Eng. Journ.*, July, 1936, Vol. 29, Part 2, pp. 124–129.)

3627. Ultra-Short-Wave Radio Circuit of the Radio Corporation of America [First Demonstration of New-York/Philadelphia 3 m Waveband Circuit with Unattended Relay Stations at New Brunswick and Arney's Mount].—(*Science*, 19th June, 1936, Vol. 83, pp. 600–602.)

3628. Arrangement for Two-Way Wireless Conversations on One Frequency, in which the Receiver is Locked while the Emitter is Working [Small Locking Voltage obtained by Receiving with Beat Oscillator which is Locked until the Incoming Oscillations cease].—Thom: Telefunken. (*Hochf:tech. u. Elek:akus.*, May, 1936, Vol. 47, No. 5, p. 176: German Patent 624 003 of 23.8.1934.)

3629. Locomotive to Caboose Radio Communication [Discussion: the Rival Claims of Carrier-Current Working].—Ellis. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, pp. 825–826.) *See* 1620 of April; also *cf.* 2018 of May.

3630. Carrier-Frequency Broadcasting along Overhead Lines.—Werrmann. (*E.T.Z.*, 25th June, 1936, Vol. 57, No. 26, pp. 735–740.) Conclusion of the paper dealt with in 3210 of August. Compensation for attenuation and distortion variations in the line, due to meteorological conditions, and the amplitude monitoring of the service, are among the additional points here discussed.

3631. Broadcast Transmission in Norway [including Carrier-Frequency System].—W. Rabanus and S. Rynning-Tönnessen. (*Europ. Fernsprechdienst*, No. 41, 1935, p. 222.) Referred to in Werrmann's paper (3630), above.

3632. Radiodistribution by High-Frequency Currents.—Gladenbeck. (*Ann. des Postes T. et T.*, May, 1936, Vol. 25, No. 5, pp. 484–496.) Translation of the German paper dealt with in 2872 of 1935.

3633. Service Areas of Broadcasting Stations. Part III—Primary Night Coverage [Frequency is Predominating Influence in spite of Opposed Effect of Noise Reduction at Higher Frequencies: High Anti-Fading Aerials come Second only: Sky-Ray Formulae and Preliminary Discussion of Secondary Night Coverage].—Green. (*A.W.A. Tech. Review*, April, 1936, Vol. 2, No. 2, pp. 45–64). For previous parts *see* 2011 of May.

3634. Radio-Lyons Transmission.—(*Bull. de la S.F.R.*, Nov./Dec. 1935, Vol. 9, No. 5, pp. 149–154.) Reproduced, in French and English, from *Radio Magazine* articles.

3635. Practical Volume Compression [Automatic Compressor for Broadcast Stations, as used at WSFA].—Hallmann. (*Electronics*, June, 1936, Vol. 9, No. 6, pp. 15–17 and 42.)

3636. The "Tone Meter," for Broadcast Programme Control.—Thilo and Bidlingmaier. (*See* 3457.)

3637. Radio on Germany's Latest Floating Island [Transatlantic Aircraft Depot Ship "Ostmark"].—(*Wireless World*, 31st July, 1936, Vol. 39, p. 99.)

3638. New High-Frequency [above 1500 kc/s] Allocations.—(*Electronics*, June, 1936, Vol. 9, No. 6, pp. 31–32.)

3639. Radio Transmission Survey of Ohio [for Highway Patrol Network].—Higgy and Shipley. (*Ohio State Univ. Engineering Experiment Station*, Bulletin No. 92, May, 1936, 18 pp.) The full report, an abbreviated form of which was dealt with in 2089 of June.

3640. A.W.A. ¼ kW AUTOMATIC DISTRESS TRANSMITTING AND RECEIVING EQUIPMENT, TYPES K 13 AND K 13A.—Moore. (*A.W.A. Tech. Review*, April, 1936, Vol. 2, No. 2, pp. 75–79.)

GENERAL PHYSICAL ARTICLES

3641. A SIMPLE [Numerical] RELATION BETWEEN THE QUANTITIES *e*, *c* AND *h*.—Ambrose Fleming. (*Nature*, 13th June, 1936, Vol. 137, p. 991.)

3642. STRUCTURE OF LIGHT WAVES.—Japolsky. (*See* 3302.)

3643. DETERMINATION OF THE TOWNSEND IONISATION COEFFICIENT α FOR PURE ARGON.—Kruithof and Penning. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 515–533 : in English.)

3644. ON THE VELOCITY DISTRIBUTION OF ELECTRONS IN ELECTRICAL FIELDS. II.—Davydov. (*See* 3284.)

3645. CALCULATION OF THE VELOCITY DISTRIBUTION OF THE ELECTRONS IN GASEOUS DISCHARGES IN HELIUM.—Smit. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 543-560 : in German.)

3646. THE ENERGY DISTRIBUTION OF ELECTRONS IN AN ELECTRIC FIELD IN A GASEOUS COLUMN, *and* THE DISTRIBUTION OF ENERGIES OF ELECTRONS [in Luminous Discharge Columns].—Kelly : Townsend. (*See* 3286 and 3285.)

3647. THE TECHNIQUE OF PRODUCING LOW-PRESSURE HIGH-FREQUENCY ELECTRICAL DISCHARGES DUE TO A SOLENOID IMMERSED IN THE GAS UNDER EXAMINATION.—Stuhlman. (*Phys. Review*, 1st June, 1936, Series 2, Vol. 49, No. 11, p. 861 : abstract only.)

3648. INFLUENCE OF MAGNETIC FIELD ON THE DIELECTRIC CONSTANT OF LIQUIDS [in Field of 26 Kilogauss, Increase in D.C. of Nitrobenzene found when Electric and Magnetic Fields are mutually Parallel or Perpendicular : No Change in Much Weaker Field].—Chatterjee. (*Indian Journ. of Phys.*, May, 1936, Vol. 10, Part 3, pp. 233–236.) *Cf.* Piekara, 1627 of April and back references.

3649. ELECTRICAL CHANGES IN INTERFACIAL FILMS [of Organic Liquids : Increase of D.C. Conductance with Increasing Thinness].—Teorell. (*Nature*, 13th June, 1936, Vol. 137, pp. 994–995.)

MISCELLANEOUS

3650. A GENERALISATION OF MAXWELL'S DEFINITION OF SOLID HARMONICS TO WAVES IN *n* DIMENSIONS.—van der Pol. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 393–397 : in English.)

Author's summary :—The author shows that the expression for a potential, using spherical functions, given by Maxwell for the case of space of three dimensions, may be generalised for space of *n* dimensions and for the equation of waves by means of a formula of an analogous type, using as well Bessel and Gegenbauer functions.

3651. A POTENTIAL AND WAVE FUNCTIONS IN *n* DIMENSIONS.—van der Pol. (*Physica*, June, 1936, Vol. 3, No. 6, pp. 385–392 : in English.)

Author's summary :—It is known that it is possible to obtain a solution of the equation of waves in space of *n* dimensions, starting from a solution in space of $n + 1$ dimensions (Hadamard's "method of descent.") The writer gives some new examples of the application of this method, containing discontinuities, obtained by symbolic calculus. He then shows that such a solution can also be obtained by starting from a solution in space of $n - 1$ dimensions ("method of ascent.") He thus obtains in a simple manner, and in a rather more general form, the classic expressions for potential and waves given by Whittaker for the case of space of three dimensions. The examples given make use of Bessel and Hankel functions and spherical functions of the two types.

3652. A DISCUSSION ON THE DERIVATION OF HEAVISIDE'S EXPANSION THEOREM BY THE SUPERPOSITION LAW [Bromwich's Integral as a Generalisation of Wagner's Integral from Standpoint of Superposition Law].—Miyoshi. (*Journ. I.E.E. Japan*, March, 1936, Vol. 56 [No. 3], No. 572, pp. 199–204 : English summary p. 17.)

3653. OPERATIONAL REPRESENTATION OF THE PARABOLIC CYLINDER FUNCTION.—Varma. (*Phil. Mag.*, July, 1936, Series 7, Vol. 22, No. 145, pp. 29–34.)

3654. A GENERALISED INFINITE INTEGRAL THEOREM : DISCUSSION.—Malti. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, pp. 826–830.) *See* 357 of January.

3655. REMARK ON THE LIMITS OF VALIDITY OF THE GALERKIN APPROXIMATION METHOD FOR EIGENVALUE PROBLEMS.—Romberg. (*Tech. Phys. of USSR*, No. 5, Vol. 3, 1936, pp. 489–491 : in German.)

3656. ON A CASE OF SELF-RECIPROCITY IN THE [Fourier] COSINE TRANSFORM.—Johnson and Phillips. (*Phil. Mag.*, July, 1936, Series 7, Vol. 22, No. 145, pp. 206–208.)

3657. FOUNDATIONS OF THE THEORY OF ERRORS [Survey].—Kaiser. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 17, 1936, pp. 219–226.)

3658. STATISTICAL ANALYSIS OF COUNTER DATA [Theory of Statistics of Electrical Counting Devices].—Schiff. (*Phys. Review*, 1st July, 1936, Vol. 50, No. 1, pp. 88–96.)

3659. "MATHEMATICS OF MODERN ENGINEERING : VOL. I" [Book Review].—Doherty and Keller. (*Current Science*, Bangalore, June, 1936, Vol. 4, No. 12, pp. 907–908.)

3660. ELECTRIC COUNTER-SHOCK SAVES MAN FROM DEATH [Shock as Antidote to Heart Fibrillation].—(*Sci. News Letter*, 4th July, 1936, Vol. 30, p. 7.) Believed to be the first time that the discovery referred to in 3242 of Aug. has been applied to save a human life.

Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of abstracts from patents issued in the U.S.A. is also included, and these bear a seven-figure serial number.

TRANSMISSION CIRCUITS AND APPARATUS

443 589.—Preventing inductive interference in screened transmission lines carrying high-frequency signals, particularly for television.

E. L. C. White. Application date, 31st August, 1934.

443 693.—High frequency oscillatory circuit consisting of a hollow structure coupled symmetrically to a number of valve generators.

Telefunken Co. Convention date (Germany), 15th September, 1934.

443 803—Signalling system for ultra-short waves in which, in order to increase the depth of modulation, it is effected directly between the oscillation-generator and the load circuit.

L. H. Paddle. Application date, 3rd January, 1935.

445 558.—Preventing the production of undesirable harmonics in a back-coupled oscillator of the tetrode type.

Marconi's W. T. Co and O. E. Keall. Application date, 10th October, 1934.

446 044.—Wired wireless distribution of broadcast programmes through a telephone network with means for maintaining the normal use of the telephone lines.

N. V. Philips Co. Convention date (Holland), 8th March, 1935.

2 008 690.—Four-electrode oscillator which is stabilised in frequency by arranging the circuit elements as a balanced Wheatstone bridge.

J. B. Dow (assignor to Radio Corporation of America).

2 010 881.—High-powered generator or amplifier with one or more discharge tubes arranged in the grid circuit to dissipate grid charges and to prevent the main valve from burning out.

J. J. Numans (assignor to Radio Corporation of America).

2 011 290.—Maintaining the output voltage of a dynatron oscillator constant, in spite of variations in load impedance, by rectifying part of the output and feeding back the D.C. voltage to the inner grid.

P. O. Farnham (assignor to Radio Corporation of America).

2 011 927.—Wireless transmitter energised and keyed from an A.C. mains supply through gas-filled rectifier valves.

H. Chireix (assignor to Cie Generale de T.S.F.).

2 012 497.—Crystal-controlled valve in which the natural frequency of the crystal is exactly matched with that of the valve by using an inductance to offset the capacity across the crystal electrodes.

J. K. Clapp (assignor to General Radio Co.).

RECEPTION CIRCUITS AND APPARATUS

443 582.—Hernodyne receiver in which the carrier frequency is supplied from an aerial separate from and not coupled to the aerial which receives the modulated signal.

Marconi's W. T. Co. and G. M. Wright. Application date, 30th August, 1934.

443 602.—Visual tuner of the cathode ray type for use on a wireless receiver.

Ferranti; A. L. Chilcot; and M. K. Taylor. Application date, 25th September, 1934.

443 640.—Step-by-step mechanism for automatically bringing a roughly-tuned receiver into accurate resonance.

E. K. Cole and G. Bradfield. Application date, 31st August, 1934.

443 684.—Amplifier with "stabilised" feed-back so that the gain is below that liable to produce non-linear distortion but above that obtainable without reaction.

Standard Telephones and Cables (assignees of H. S. Black). Convention date (U.S.A.), 6th October, 1934.

443 956.—A.V.C. system in which the selectivity of the control and noise-suppressing circuit can be increased without affecting the overall selectivity of the receiver.

Ferranti; A. Hall; and N. H. Searby. Application date, 10th August, 1934.

444 013.—Variable-permeability tuning-coil in which the wire is wound in sections on a hollow former.

W. J. Polydorff and Aladdin Radio Patents. Application date 5th July, 1934.

444 951.—Tuning or coupling solenoid-coil wound so that the whole of the tuning capacity is uniformly distributed. Movable magnetic core. Stated to simplify selective reception.

S. G. Brown. Application dates, 27th June and 20th November, 1934.

444 972.—Muting circuit designed to give a clear-cut effect at a certain level of signal strength, and to show equal sensitivity to all signals above that level.

General Electric Co. and J. O. Ackroyd. Application date, 30th October, 1934.

445 098.—Method of ensuring that the "threshold" of self-oscillation in a back-coupled valve occurs at all frequencies, at a given setting of the reaction control.

N. V. Philips. Convention date (Germany), 5th January, 1935.

445 273.—Muting circuit for a wireless receiver in which the suppressor voltage also provides a measure of automatic gain control.

E. S. V. Truefitt and R. E. Spencer. Application date, 5th September, 1934.

445 496.—Remote control of a superhet receiver secured by varying the effective impedance of the local oscillator valve.

E. K. Cole and A. W. Martin. Application date, 1st December, 1934.

445 922.—Coupling system for a superhet receiver designed to increase the width of side-band acceptance whilst maintaining a constant gain factor

Hazeltine Corp. (assignees of J. K. Johnson). Convention date (U.S.A.), 22nd May, 1934.

SOME RECENT PATENTS

445 968.—Combined short and medium wave receiver, suitable for television and sound signals, fed from a single complex aerial.

E. C. Cork; A. D. Blumlein; and E. L. C. White. Application date, 17th August, 1934.

2 011 943.—Ultra short-wave receiving system in which a push-pull amplifier of the Barkhausen-Kurz type is coupled to the aerial through " trombone-tuned " Lecher-wires.

N. E. Lindenblad (assignor to Radio Corporation of America).

2 013 331.—Portable remote-control unit for a fixed radiogram set.

M. Alden (assignor to Radio Inventions Inc.).

2 017 192.—Compensating for valve curvature by using coupling-resistances of a non-linear type, particularly porcelain impregnated with fine particles of conducting material.

I. Wolff (assignor to Radio Corporation of America).

2 022 514.—Wireless receiver with constant coupling giving uniform sensitivity over a wide frequency range.

W. A. MacDonald (assignor to Hazeltine Corporation).

VALVES AND THERMIONICS

443 777.—Electron discharge amplifier of the type in which a number of secondary-emission " targets " are arranged in cascade between cathode and anode in a single tube.

J. D. McGee. Application date, 5th July, 1934.

443 906.—Multi-grid frequency-changing valve particularly for use in superhet or homodyne receivers.

C. S. Bull. Application date, 6th September, 1934.

2 012 431.—High-powered short-wave transmitting valve with an electrode assembly designed to prevent the formation of standing waves on the grid.

I. E. Mouromtseff (assignor to Westinghouse Electric and Manufacturing Co.).

DIRECTIONAL WIRELESS

443 992.—Short-wave radio navigation system in which the transmitted beam is modulated by being passed through gas-filled tubes of variable ionisation.

Marconi's W. T. Co. (assignees of I. Wolff). Convention date (U.S.A.), 26th April, 1934.

444 005.—Method of keying a radio beacon station, transmitting two overlapping beams which define a course to be flown by an aeroplane.

C. Lorenz Akt. Convention date (Germany), 5th October, 1934.

2 017 909.—Direction-finder in which each earpiece of the headphones is switched alternately into circuit in order to facilitate the comparison of signal strengths.

A. Leib (assignor to Telefunken Co.).

2 007 477.—Radio navigation system for aeroplanes in which deviation to port or starboard is indicated by the dimming of one or other of two signal lamps.

F. E. Nickel (assigned in part to R. A. Keirle and W. E. Phillips).

TELEVISION AND PHOTOTELEGRAPHY

443 896.—Method of scanning on a screen composed of bands or zones giving differently-coloured fluorescence, or otherwise differentiated, so as to produce coloured or stereophonic effects.

General Electric Co. and L. C. Jesty. Application dates, 6th October 1934 and 6th March, 1935.

443 952.—Generating saw-toothed oscillations suitable for scanning a " keystone " area, such as occurs in a cathode ray tube where the picture is projected on to an inclined mosaic-cell electrode.

M. Bowman-Manifold. Application date, 4th July, 1934.

444 065.—Method of transmitting the synchronising impulses used in television.

Telefunken Co. Convention date (Germany), 9th September, 1933.

444 177.—Receiving circuit for television signals with synchronising impulses superposed on the same carrier wave.

C. S. Agate and W. S. Percival. Application date, 15th August, 1934.

445 428.—Separating the frame and line scanning impulses from the picture signals in a television receiver.

Radio-akt. D. S. Loewe. Convention date (Germany), 11th October, 1933.

445 820.—Securing a sharply-focussed spot of high light-intensity from a low velocity stream on a cathode-ray tube.

F. J. G. van den Bosch. Application date, 10th July, 1935.

SUBSIDIARY APPARATUS AND MATERIALS

443 816.—Double-cone loud-speaker with resonance walls forming a closed casing.

Lenzola Lautsprecher-Fabrik. Application date, 7th June, 1935.

443 981.—Gramophone pick-up in which the movement of the stylus is used to vary the incidence of a ray of light upon two photo-electric cells arranged in push-pull.

R. G. Johnson (communicated by E. N. Johnson). Application date, 23rd October, 1934.

2 018 246.—Method of re-cutting or grooving a piezo-electric crystal in order to correct an error in the initial grinding.

J. G. Beard (assignor to Westinghouse Electric Co.).